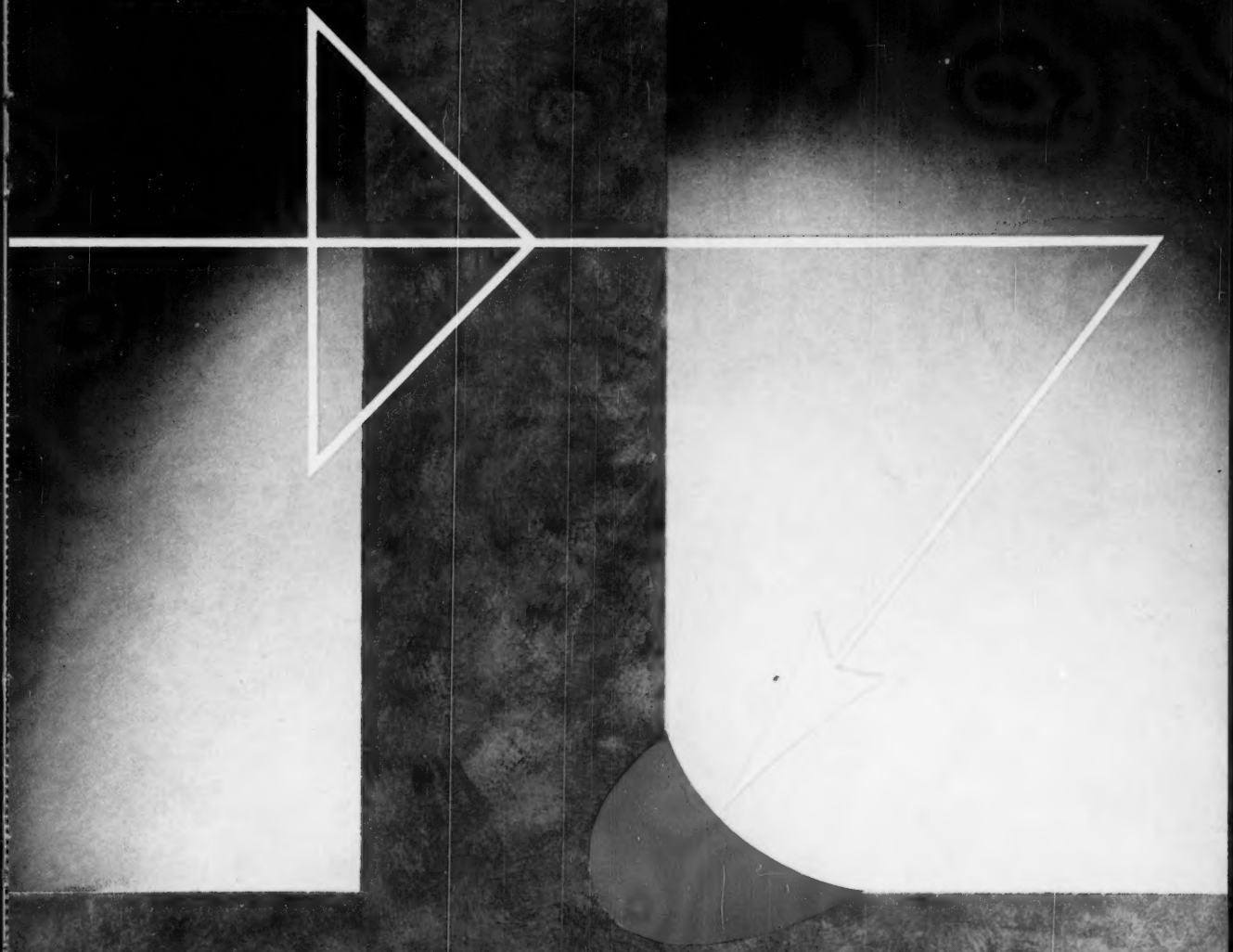
SEPTEMBER 19, 1957

MACHINE DESIGN

A PENTON PUBLICATION — BIWEEKLY



Weldments

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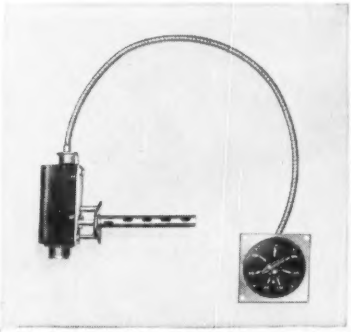
FARNSWORTH

S.S.White Flexible Shafts Withstand Temperature Extremes!

A leading aircraft manufacturer has used S.S. WHITE flexible shafts for many years to transmit control between this graduated dial and aircraft thermostat. He finds that under any kind of temperature conditions, there is no measurable variation in torque to turn the shaft, or in torsional deflection required to initiate cam movement over the temperature range!

This ability to withstand temperature extremes is only one of the many remote control and power drive advantages industry has discovered in S.S. WHITE flexible shafts. Perhaps they can help you to simplify control or product design . . . cut your production costs . . . speed assembly. These quality shafts range from small to large sizes, and up to 12 feet in length. The assistance of our engineering staff in helping you work out a flexible shaft application for your product is yours for the asking. Just write to



S.S.White

FIRST NAME IN FLEXIBLE SHAFTS

USEFUL DATA on how to select and apply flexible shafts. Write for Bulletin 5601.

S. S. White Industrial Division, Dept. 4, 10 East 40th St., New York 16, N. Y. Western Office: 1839 West Pico Blvd., Los Angeles 6, Calif.

Circle 401 on page 19

The Best costs less than you may think

Check these sensible prices on the . . .

Ross Skyline air valve series

The line designed for extra long life. Lab tests indicate life of Silvermodels and Whitemodels: 25 million cycles; Goldmodels and Bluemodels: 40 million cycles.

(Quantity and OEM discounts reduce these prices)

Solenoid Operated Valves

⅜" Three-way, normally-closed, line mounted, Spool Solenoid (Whitemodel) **32.50**

⅜" Four-way, base mounted Spool Solenoid (Whitemodel) **57.50**

⅜" Straightway, normally-closed, line mounted, JIC Spool Solenoid (Silvermodel) **34.50**

¼" Straightway, normally-closed, line mounted, JIC Spool Solenoid (Silvermodel) **42.50**

⅜" Three-way, normally-closed, line mounted, JIC Spool Solenoid (Silvermodel) **37.50**

⅜" Four-way, base mounted, JIC Spool Solenoid (Silvermodel) **62.50**

¼" Four-way, base mounted, JIC Spool Solenoid (Silvermodel) **87.50**

⅜" Straightway, normally-closed, line mounted, JIC oil-immersed solenoid (Goldmodel) **44.50**

⅜" Three-way, normally-closed, line mounted, JIC oil-immersed solenoid (Goldmodel) **47.50**

Pressure Operated Valves

⅜" Three-way, timed-in or timed-out, normally-closed, pressure operated sequence valve—line mounted (Bluemodel) **25.50**

¼" Three-way, normally-closed, pressure operated master valve — line mounted (Bluemodel) **25.00**

⅜" Four-way, timed-in or timed-out, pressure operated sequence valve — base mounted (Bluemodel) **50.00**

¼" Four-way, pressure operated master valve— base mounted (Bluemodel) **67.50**

Speed Controls for use with your Skyline Valves

⅜" Speed control valve **5.50**

¼" Speed control valve **8.50**

1¼" Speed control valve **19.50**

All Prices F.O.B. Detroit

Any Skyline Head Attaches to Any Skyline Body

Ross OPERATING VALVE COMPANY

109 EAST GOLDEN GATE AVENUE • DETROIT 3, MICHIGAN

Circle 404 on page 19

Positive Load Transfer

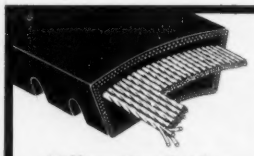
The special "floating gum" insulating section transfers the load to the carrying cords—prevents chafing.

True Dimensional Stability

It's muscled by the exclusive Triple-Tempered (3-T) Cord to give you true dimensional stability in storage and in service.

Highest Transverse Rigidity

The special compression section of fiber-reinforced synthetic rubber strongly resists dishing under side pressure—protects from undue fatigue.



Uniform Cross Section

Precision molding assures an always uniform cross section throughout the length of each belt.

NOW— AN INVARIABLE CURE

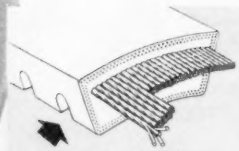
to variable speed drive headaches

Assured Balance of Yield

The special "cool-running" tension section makes the top of the belt yield in exactly the opposite direction as the bottom—equalizes pull on either side.

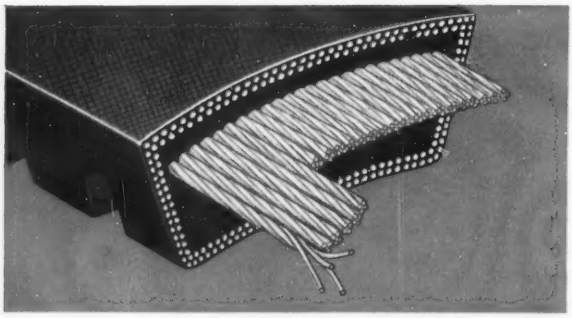
Excellent Gripping Ability

The specially compounded, highly abrasion-resistant cover assures a strong, uniform grip on both faces of the sheave.



Controlled Flexibility

Completely uniform notching gives you the flexibility to bend over small pulleys—without sacrifice of cross-rigidity or strength.



HERE, at last, is a belt with all the answers to one of your toughest of belting problems: harnessing variable speed drives. It's the great new Goodyear Variable Speed Belt—developed through years of research and testing.

And it brings you all the Goodyear *extra-quality* features that assure the maximum, trouble-free horsepower hours at minimum cost. For more details, contact the G.T.M. —Goodyear Technical Man—through your Goodyear Distributor. Or write Goodyear, Industrial Products Division, Akron 16, Ohio.

VARIABLE SPEED BELTS by **GOODYEAR**

THE GREATEST NAME IN RUBBER

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Sept. 19, 1957 Volume 29—No. 19

THE PROFESSIONAL JOURNAL FOR ENGINEERS AND DESIGNERS

MACHINE DESIGN

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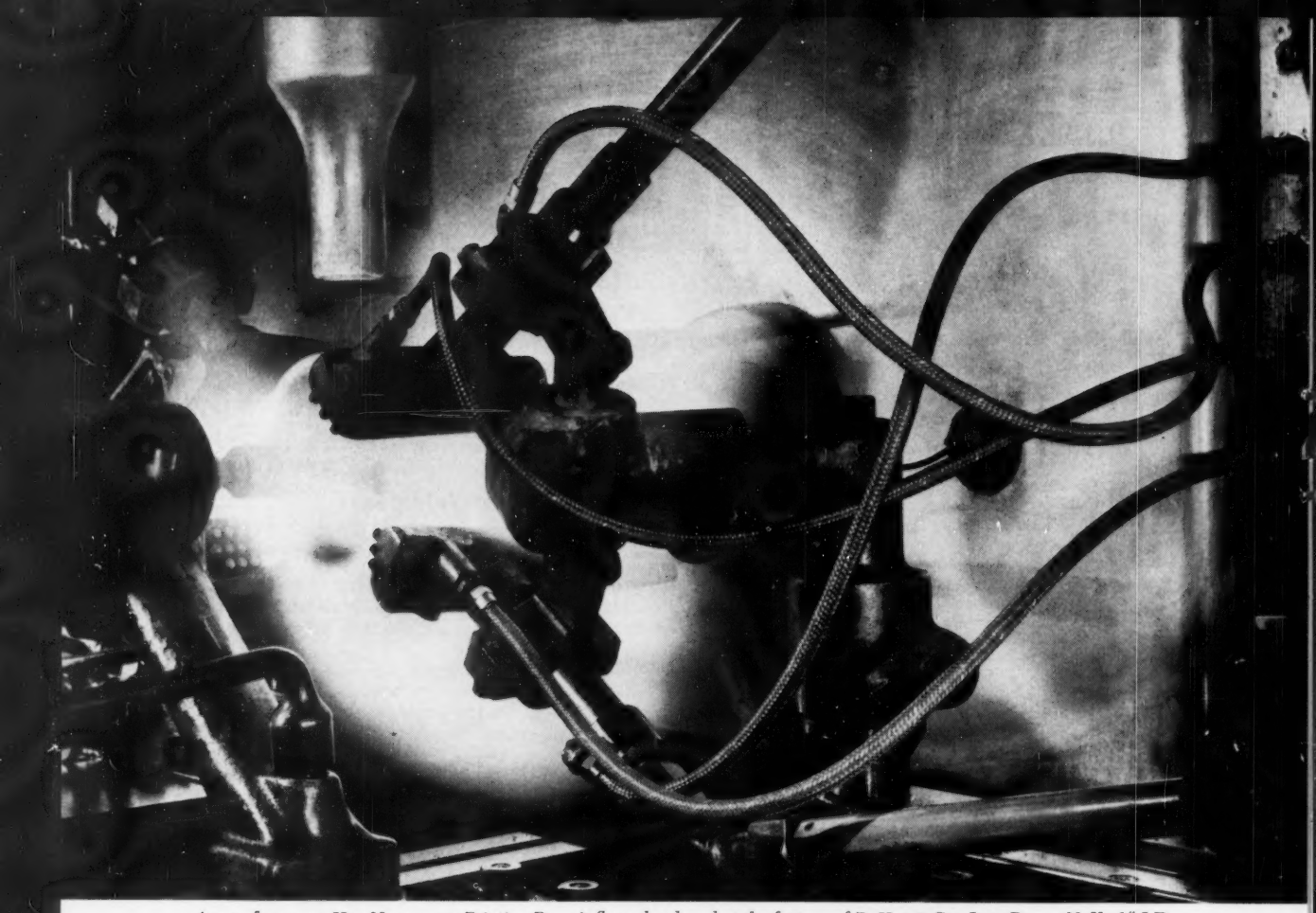

A gear for a new Hoe Newspaper Printing Press is flame-hardened at the factory of R. Hoe & Co., Inc., Bronx, N. Y. 1" I.D. seamless bronze American Flexible Metal Hose on the flame hardening machine, shown here, conveys acetylene gas.

Design Problem:

Leakproof gas lines that must flex
. . . withstand heat from outside
. . . corrosive attack from within

Answer:

American Metal Hose

This machine hardens, brazes, and heat processes metal products and parts. The flame heads are adjustable; so the hoses conveying the fuel gas must be flexible. And they must be tough! Corrosive gas attacks them from the inside. High heat is a constant enemy on the outside. Yet they must be leakproof. For safety's sake, they must not fail.

The engineers found the right answer: American Flexible Metal Hose. It delivers more service hours per dollar!

Available in wide range of diameters in bronze, brass, aluminum, steel, monel, stainless steel and other metals—American Flexible Metal Hose is being used by countless manufacturers to convey almost every conceivable gas and liquid . . . to absorb vibration . . . absorb expansion and contraction in lines due to temperature changes . . . facilitate installation, especially in cramped spaces . . . to solve the problem of misalignment.

American furnishes flexible metal and Teflon connectors to your specifications . . . ready for immediate installation. Consult your nearby American Metal Hose representative for engineering help when planning your next job. Just released! New 64-page catalog chock-full of useful information on flexible metal hose and tubing. Write for your free copy: The American Brass Company, American Metal Hose Division, Waterbury 20, Conn.

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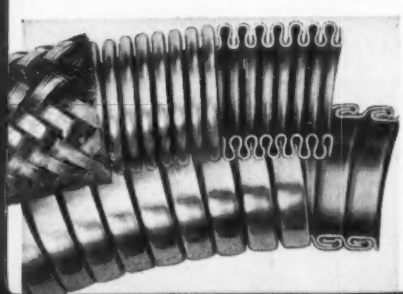


BASIC TYPES

Seamless corrugated and Strip-wound. Both types available in a wide range of sizes and styles in any workable metal. Furnished with or without end fittings attached.

WHEREVER CONNECTORS MUST MOVE

AMERICAN

FLEXIBLE METAL HOSE AND TUBING

AN ANACONDA® PRODUCT

Circle 406 on page 19

Engineering News Roundup

Speeds over 3000 mph Sought in Land Vehicle

Track Contacts Found Critical In 1000-mph Prototype

BURBANK, CALIF. — Speeds up to 3750 mph are expected from rocket sleds now in the preliminary design stage at Century Engineers Inc. Know-how to obtain this performance is being accumulated on equipment considered capable of 1000 mph, currently installed at the Edwards Air Force Base Supersonic Track Facility.

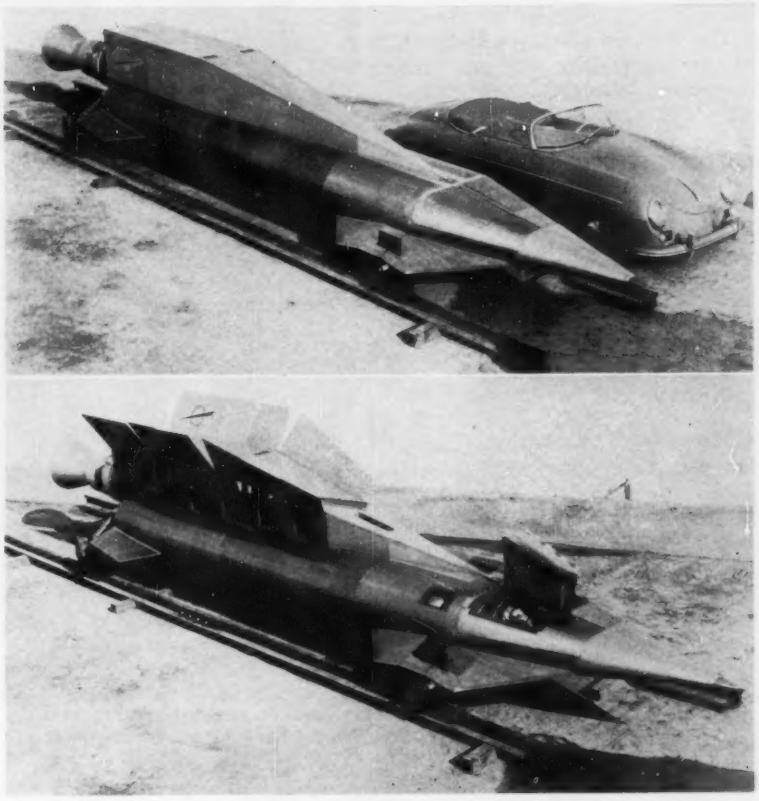
The present vehicle is a multipurpose sled propelled by rockets which carry a liquid oxygen-alcohol fuel. In addition to the speed and liquid fuel, the Air Force had specified provisions for mounting test specimens outside the vehicle, capability of the sled to push other vehicles, large housings for instruments, and easy access to the sled's power plant and controls.

The Lox-Alcohol engine, made by North American Inc., delivers a thrust of 50,000 lb, and booster units can be added.

The sled is decelerated by a horizontal discharge water brake. A scoop picks up water between the rails and discharges through ports on each side of the sled. The brake stops the 5000-lb sled in approximately 1500 ft.

Points of hardest service on the sled are its four slippers. Braking and aerodynamic ground effects add to slipper wear caused by high velocities. Currently, slippers have Stellite or stainless-steel inserts to resist wear. Key to speeds in the 3000-mph range may be slippers of new design and new material.

In first test runs, the sled has attained speeds up to 1080 mph. Structural integrity of the chassis and the fairing has been proved satisfactory.



Fairings on this test vehicle provide a minimum of aerodynamic drag, help attain speeds up to 1000 mph. Covers give access to instrument chambers, controls, motor. Pylons above slippers are external instrument mounts.

Groundwork Begun on International Atom Standards

Glossary, Symbols Sought By U. S.-Led Committee

NEW YORK — First steps toward world standardization in the peaceful use of nuclear energy were taken at a meeting of the International Organization for Standardization (ISO), Geneva, Switzerland, July 29 to Aug. 1.

Under the chairmanship of Morehead Patterson, president and chairman of the board, American Machine and Foundry Co., the first meeting of ISO Technical Committee 85 on Nuclear Energy outlined six areas of work. They are:

1. A trilingual glossary of terms.

2. A warning symbol for use wherever danger from ionizing radiation is present.

3. Adoption of units pertaining to nuclear energy, developed by the International Commission on Radiation Protection and the In-

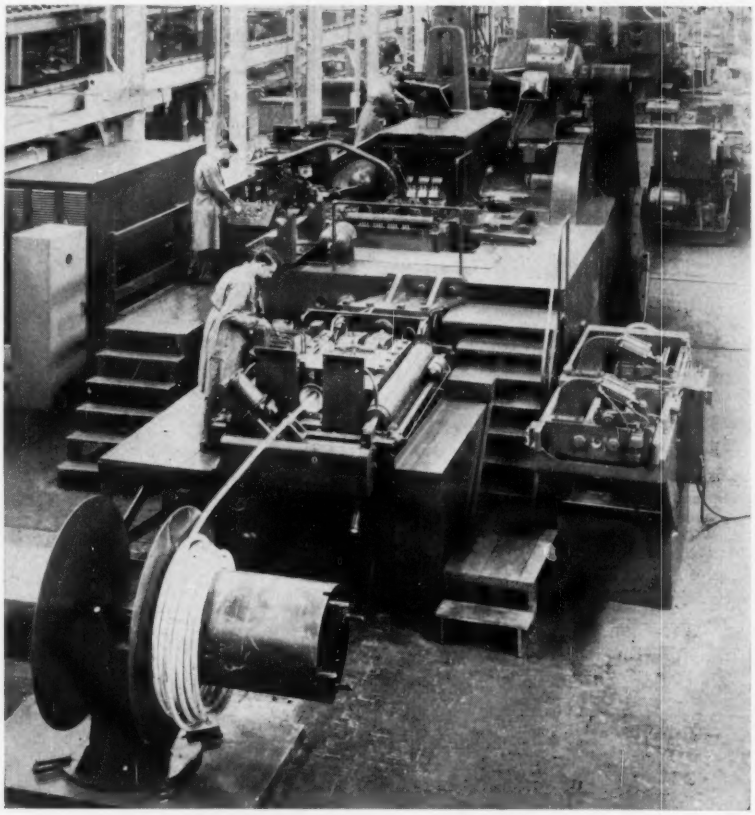
ternational Commission on Radiological Units.

4. Development of symbols required for drawings.

5. Recommendations relating to measurement of radiation and protection against radiation.

6. Guides for safe design, operation and maintenance of nuclear reactors.

The U. S. holds the secretariat of the committee through the American Standards Association. ASA had accredited 15 delegates to the meeting. A total of 61 delegates from 13 countries attended.



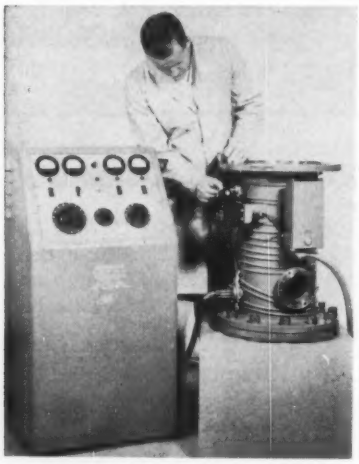
BIGGEST BOLTMAKER is this 200-ton machine, the first to produce cold steel forgings larger than $\frac{3}{4}$ in. automatically. It makes hex-head cap screws, hex and square head bolts, and high-strength structural steel bolts in sizes from $\frac{7}{8}$ to $1\frac{1}{4}$ in. diam; up to 10 in. long; at rates from 4 to 40 per minute. Machine cycle includes roll threading. Within these size limits, Boltmaker can form other odd-shaped parts like shafts, pins, rivets, gear blanks. It was built by National Machinery Co. for Cleveland Cap Screw Co.

Titanium Clears Chamber In High Vacuum Pump

Unique Electronic Device Produces Almost Nothing

ROCHESTER, N. Y.—Titanium wire is the key feature of an electronic pump that produces high vacuum without the use of organic pump fluids. The only device of its kind, the pump creates a "dry" vacuum in the range of 10^{-4} to 10^{-8} mm Hg. It employs the "gettering" action of evaporated titanium wire to exhaust active gases. It pumps inert gases by ionizing and burying them under a layer of titanium.

Named Evapor-Ion, the pump is made by Rochester Div., Consolidated Electrodynamics Corp. The latest model, Type EI-2000A, has a pumping speed of 1900 liters per second for nitrogen, 1000 liters per second for oxygen, and 3000 liters per second for hydrogen. It also pumps water vapor.



Evapor-Ion pump uses titanium wire in an electronic process to produce high vacuum. Controls are at left.

Operation of the new pump is possible for periods up to six months or longer without breaking vacuum for pump servicing. A new power supply provides three times the accelerator grid current formerly possibly. It also permits easier starting of the pump by simultaneous power application to the electrodes and firing of the primers used for roughing out. The primer charges have a combined absorption capacity of 360,000 micron-liters of active gases.

A new ten-passenger jet transport plane, recently flight tested by Lockheed Aircraft Corp., was developed in a record time of 30 weeks. Named *Jetstar,* the plane is powered by two British Orpheus engines mounted in pods attached to the rear of the fuselage. It carries a two-man crew, will fly 500 mph, higher than 40,000-ft.

Front Cover

A welding symbol is transformed into an actual welded joint by the magic of George Farnsworth's brush. The more workaday methods of getting from a designer's symbolic concept to a real-life weld are covered in John Mikulak's article on Page 135.

. . . Fluid Power news

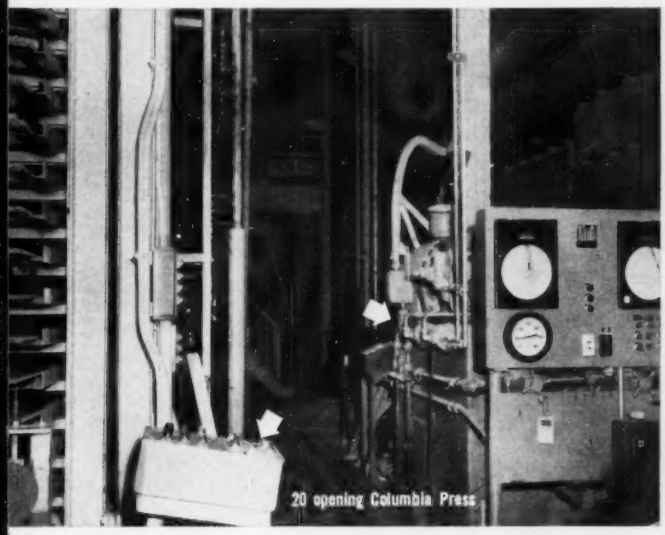
REPORT NO. 11,500 PACKAGED POWER FOR PRESSES

From Oilgear Application-Engineering Files

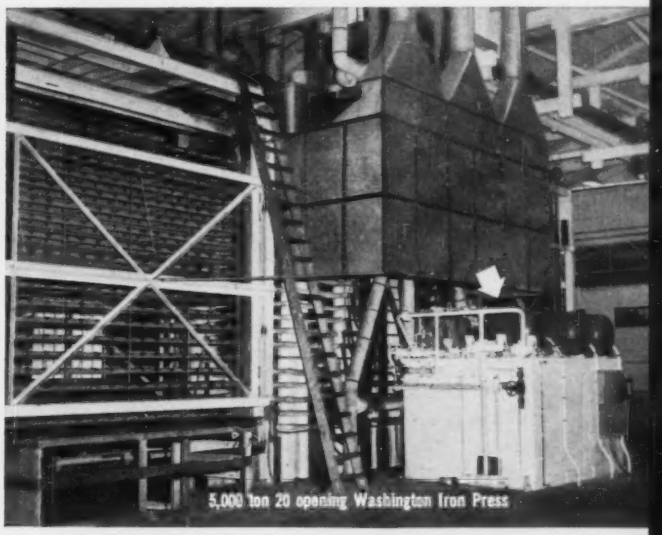
HOW OILGEAR SYSTEMS BOOST QUALITY PRODUCTION—CUT OPERATING COSTS

CUSTOMERS: *Many Modern Hot Plate Press Builders and Users (Names Withheld)*

DATA: For presses with capacities ranging from 500 to 5,000 tons, or two-press operation. It is desirable to have one company responsible for the entire power system, rather than an assembly of components of different origin. Should have remote, preset, accurate, automatic push button control of multiple time cycles, pressures, and ram speeds to improve quality—increase production. "Presets" to be simply, rapidly adjusted by user personnel. High speed platen approach and return needed to increase productive cycles per hour. Remote location of equipment to prevent absorption of heat from the press . . . with a minimum of piping to keep maintenance and installation costs to a minimum. Systems must be leak-tight, trouble-free, dependable, capable of virtually continuous operation.



20 opening Columbia Press

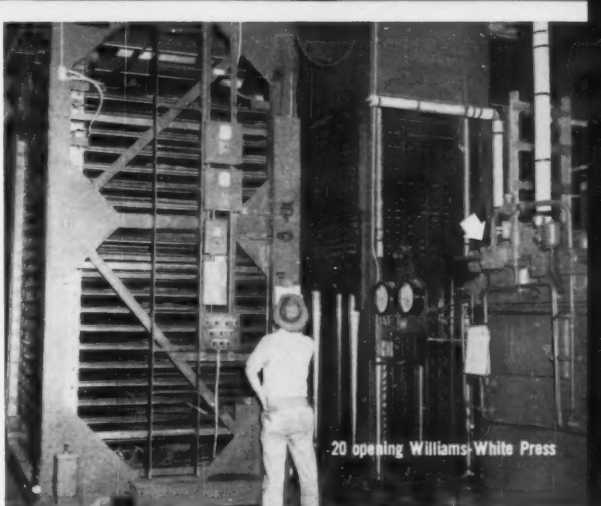


5,000 ton 20 opening Washington Iron Press

SOLUTION: Shown are three typical installations where Oilgear "Power-Paks" have been application-engineered by Oilgear—with the press manufacturers—to achieve the modern concept of high speed automatic production of hardboards and plywood. These are complete Oilgear Fluid Power systems that include pumps, motors, reservoir, valves, and controls custom-built into a single "Power-Pak." Oilgear "Power-Paks" offer many advantages other than a mere unitized assembly . . . automatic conservation of electrical power . . . precision-controlled, variable cycle times and board pressures—with a complete choice of controls ranging from manual to completely automatic, remote push button . . . high-speed platen approach and return . . . leak-tight welded fittings and pipe joints . . . completely pressure and flood lubricated by the oil in the system—assuring long, trouble-free, dependable life. Oilgear's complete "Power-Paks" eliminate costly hand-fitted assemblies, unnecessary engineering, excessive power loss, leaks, repetitive malfunctioning, "Christmas tree" appearance. Press manufacturers and users alike report . . .

"For the lowest cost per year—it's Oilgear!"

For practical solutions to YOUR *linear or rotary drive and control problems, call the factory-trained Oilgear application-engineer in your vicinity. Or write, stating your specific requirements, directly to . . .*



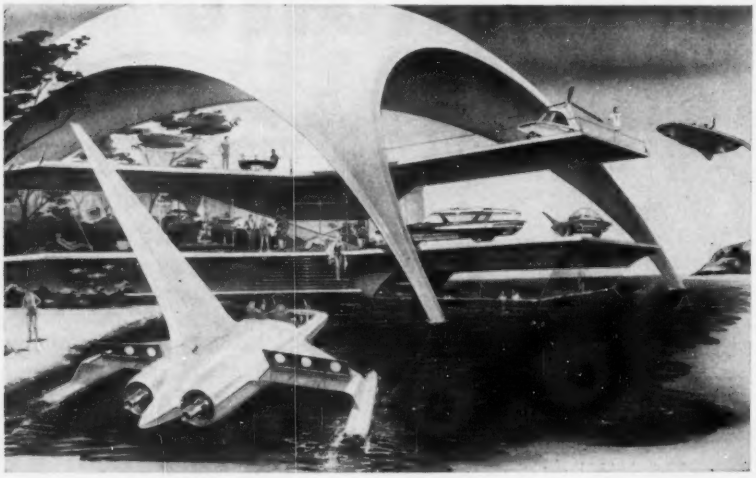
20 opening Williams-White Press

Oilgear application-engineered Fluid Power systems are not limited to linear drives for hot plate or pulp baling presses. They are highly successful on rotary drive applications as veneer clippers, sawmill carriages, feed rolls, resaws, gang saws, edgers, trimmers, log handling equipment, transfer systems, winders and calenders. For controlled, linear or rotary power—check with Oilgear!

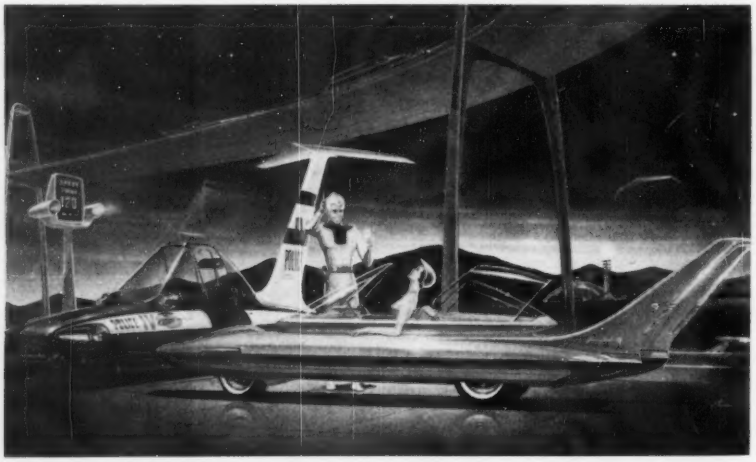
THE OILGEAR COMPANY

Application-Engineered Fluid Power Systems

1568 WEST PIERCE STREET • MILWAUKEE 4, WISCONSIN



TRIPLE THREAT VEHICLES of the future capable of land, sea or air travel are foreseen by Ford Motor Co. "visioneers" of advanced styling. Although auto stylists are primarily at work on models scheduled for three years hence, long-range planning provides key to successful styling, according to Ford planners. Few concepts are regarded as too remote for exploration; they may contain the basis for new shapes and design features of immediate value. Aquacar pictured here would provide handy air-water transportation for fast weekend excursions. Future sports car, below, is pictured in typical roadside situation as woman driver explains necessity for exceeding 120 mph speed limit. Present developments in aerodynamics and propulsion put these conveyances in the realm of possibility; traffic handling facilities cloud their immediate adoption in urban areas, at least.



Radar Patent Granted To Pioneering Scientist

WASHINGTON, D. C.—A fundamental patent for radar under which the government has a royalty free license was granted recently by the U. S. Patent Office in the name of Colonel William R. Blair, retired U. S. Army Signal Corps scientist. The patent is considered to be as important and far-reaching in its military application as the first U. S. patent issued on the telephone was to commercial communication.

The pulse-echo method of direction finding and ranging was conceived prior to 1930 by Colonel Blair and was developed during the 1930's at the Signal Corps

Topics

Riding the rails in style, namely in a 1957 Pontiac station wagon, is a new mode of travel for executives of the Chicago & Eastern Illinois Railroad. The highway-railway car, used in inspecting roadbed and track, has an extra set of flanged wheels which are raised and lowered hydraulically and locked in position.

• • •

Six largest propellers, 24 ft in diameter, will be made for a fleet of oil tankers by Eddystone Div. of Baldwin-Lima-Hamilton Corp. Three will be of manganese bronze and will be the heaviest ship propellers ever cast, weighing 90,000 lb each. The others will weigh 75,000 lb each and will be made of Nialite, a zinc-free, nickel-bearing alloy.

• • •

Charcoal broiling indoors—without charcoal—is made possible by a new grill made by Otto Bernz Co. Meat cooks on a rack above a ceramic block which is heated by gas burners. Fat drippings from the meat fall onto the block and burn, producing carbon that gives the meat a charcoal flavor.

• • •

Poor detail design puts the miss in missiles that fail, according to Richard Reinnagel, missile engineer at Cornell Aeronautical Laboratory. Without the aid of human intelligence that guides manned aircraft, says Mr. Reinnagel, missile performance depends upon the function of an unattended system in a different environment from that in which it was set up and adjusted.

• • •

Nicer to be near because it doesn't smoke so much, a diesel engine model developed by Pennsylvania State University researchers eliminates excessive exhaust fumes. Cutting down on smoking has also increased power and efficiency of the engine.

• • •

Musical chair, a wing back type made by Stereo Products Co., has speakers built into the wings. The effect is much like hi-fi reception with earphones. Speakers have volume controls and a switch for converting to a monaural system.

Circle 407 on page 19→

POROUS BRONZE BEARINGS
SELF-LUBRICATING BRONZE BEARINGS
BRONZE SINTERINGS
BRONZE POWDERED METAL BEARINGS
OIL-RETAINING BRONZE BEARINGS
SINTERED METAL BRONZE BEARINGS
OIL-IMPREGNATED BRONZE BEARINGS
BRONZE OIL-LESS BEARINGS
POWDER METALLURGY BRONZE BEARINGS
OIL-FILLED BRONZE BEARINGS
METAL POWDER BRONZE BEARINGS

CONFUSED?

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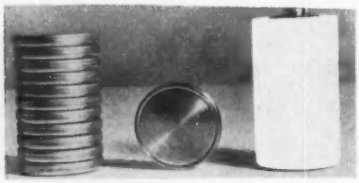
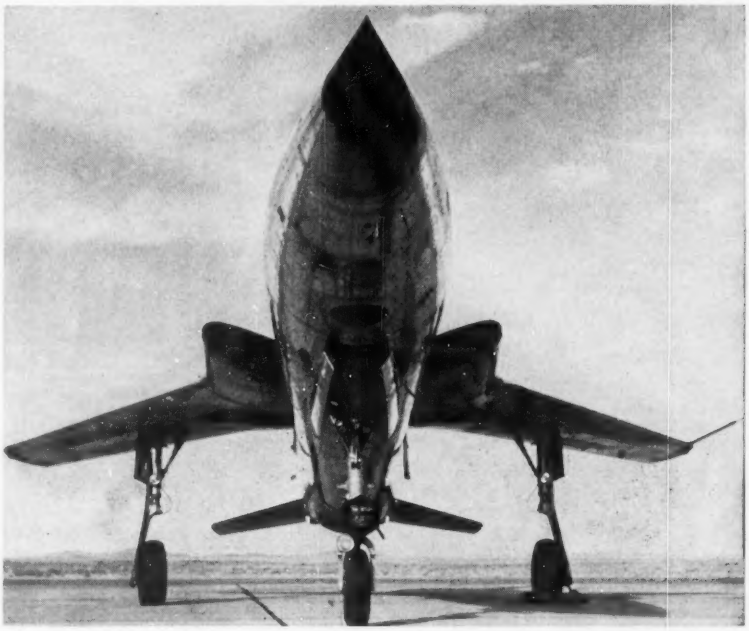
Laboratories, Fort Monmouth. By early 1937, a complete workable radar set was demonstrated for the Secretary of War and members of Congress. Plans for this set were turned over to manufacturing concerns to build radar equipment for the Army.

Due to the high degree of secrecy surrounding the development of radar, a patent application was not filed by the Army Signal Corps until June, 1945. Since that time, the matter has been under consideration for a U. S. Patent.

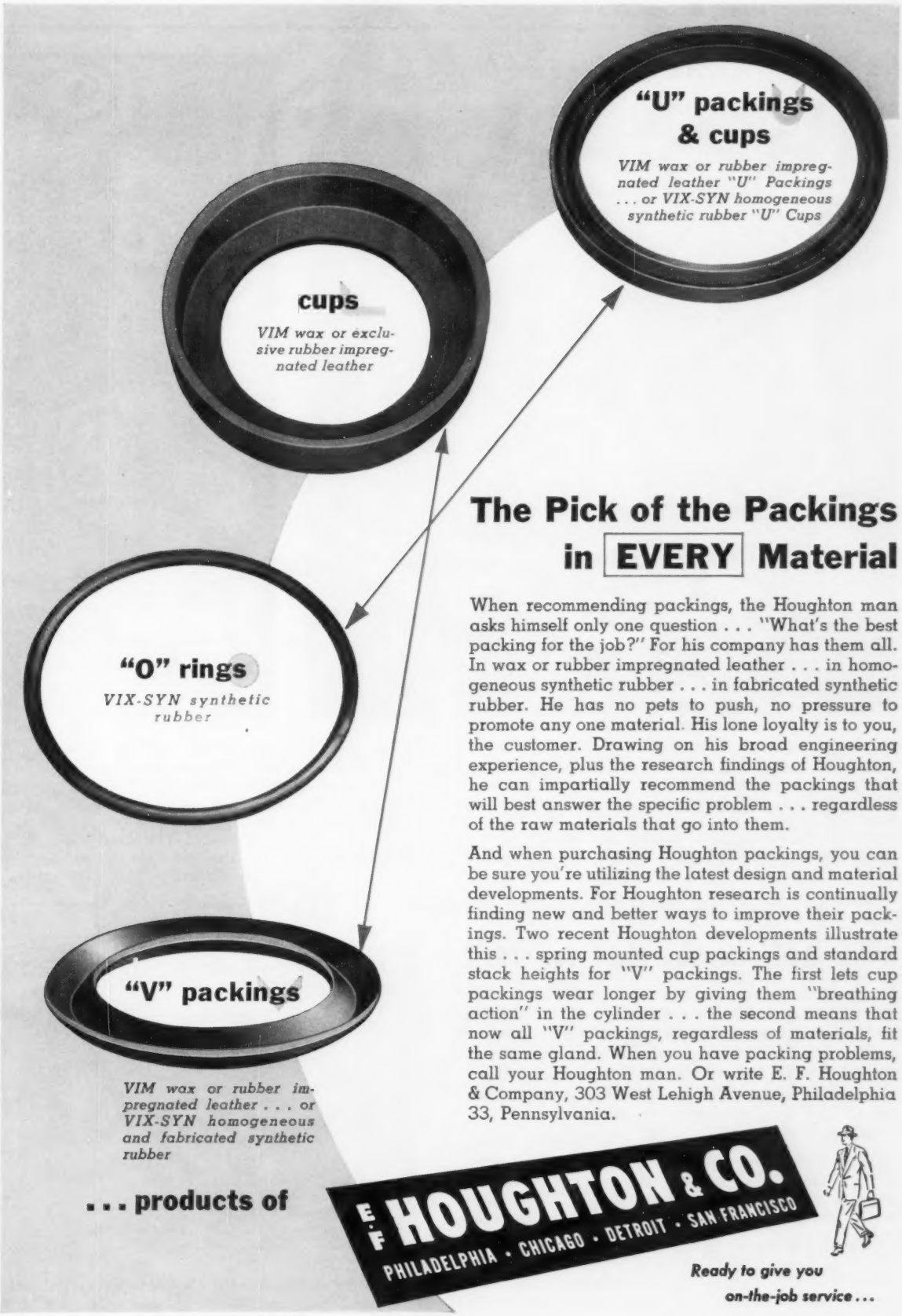


SMALLEST BATTERIES of their type are claimed to be these nickel-cadium, sintered-plate cells developed by Gulton Industries Inc. The small button cells, about the size of a half-dollar, are rated at 1.2 v, come in either 0.25 or 0.5 ma size. Cells are hermetically sealed, permanently rechargeable, can be stacked to make any size battery.



UNUSUAL DESIGN DETAILS of Republic's F-105 Thunderchief include swept forward air-intake ducts. Duct configuration reduces shock-wave effect on tail surfaces and provides wing depth for landing gear wheel wells. A third ram-air intake at base of the plane's vertical fin provides cooling air to the after end of the ship. "Clover leaf" brakes form the last 36 in. of the fuselage; fold out at right angles to the air stream to provide a 360-deg wind brake. Conical camber formation at leading edge of the wing can be adjusted in flight to reduce drag at supersonic cruising speeds. The big, one-place fighter-bomber can carry a payload of nuclear weapons internally or externally. In-flight refueling gives it global range.

SIX BAGS FULL of air at 2 psi carry this truck and 7-ton rated load across loose sand, up 76 per cent slopes, through surf and swamp. Tires absorb sharp obstacles, left, and enable crossing of wilderness bridge of two poles, right. With 1-ton load, the tires alone float the truck in water. They can be inflated and deflated from the cab with the truck in motion. Chrysler V-8, 185-hp engine inside the cab enables speeds of 40 mph on highways. All six tires are driven by friction rollers. Single roller per tire employs top-loading, top-drive principle, distributes load uniformly, minimizes displacement and consequent tire wear under load. Simple drive system eliminates spring-and-shock assemblies and walking beams. Welded aluminum frame is box-section design. Designated the 6 x 6, 7-ton Transporter, the truck is made by Albee-Rolligon Co.


"U" packings & cups
VIM wax or rubber impregnated leather "U" Packings . . . or VIX-SYN homogeneous synthetic rubber "U" Cups
cups
VIM wax or exclusive rubber impregnated leather
"O" rings
VIX-SYN synthetic rubber
"V" packings
VIM wax or rubber impregnated leather . . . or VIX-SYN homogeneous and fabricated synthetic rubber

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When recommending packings, the Houghton man asks himself only one question . . . "What's the best packing for the job?" For his company has them all. In wax or rubber impregnated leather . . . in homogeneous synthetic rubber . . . in fabricated synthetic rubber. He has no pets to push, no pressure to promote any one material. His lone loyalty is to you, the customer. Drawing on his broad engineering experience, plus the research findings of Houghton, he can impartially recommend the packings that will best answer the specific problem . . . regardless of the raw materials that go into them.

And when purchasing Houghton packings, you can be sure you're utilizing the latest design and material developments. For Houghton research is continually finding new and better ways to improve their packings. Two recent Houghton developments illustrate this . . . spring mounted cup packings and standard stack heights for "V" packings. The first lets cup packings wear longer by giving them "breathing action" in the cylinder . . . the second means that now all "V" packings, regardless of materials, fit the same gland. When you have packing problems, call your Houghton man. Or write E. F. Houghton & Company, 303 West Lehigh Avenue, Philadelphia 33, Pennsylvania.

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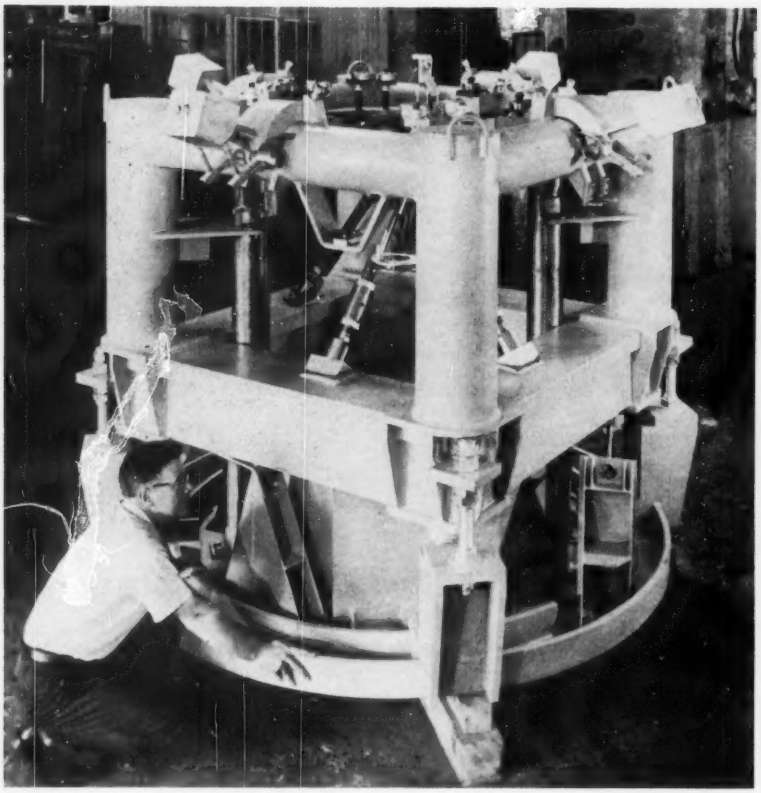
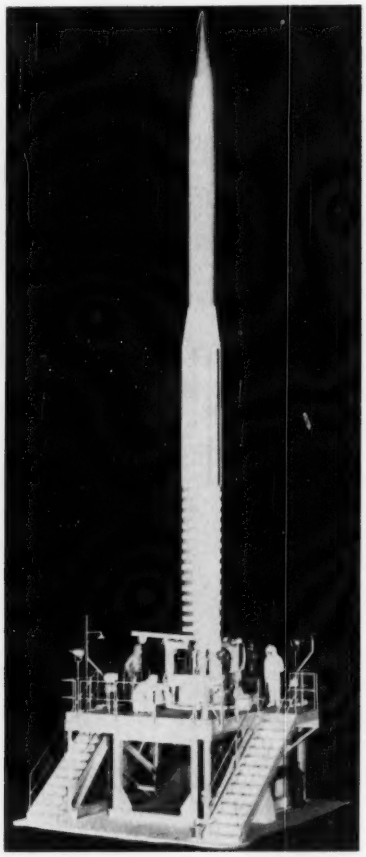
Positioning Precedes Satellite Send-Off





FIRING STAND FOR VANGUARD is a precision instrument in itself. Mounted on the launching platform, it will support and weigh the 72-ft rocket, hold it exactly vertical and disconnect more than 20 fuel and instrument lines at the instant of firing. Designed to withstand temperatures of 4000 F, the stand houses a large, curved flame deflector cooled by a high-pressure water system. Exhaust flames will be quenched and converted to relatively harmless steam. In addition to its functional components, the stand is equipped with floodlights, fog nozzles to spray out fires, a safety-shower, and emergency eye-wash fountains for protection of operating personnel. The stand was built by Loewy-Hydropress of Baldwin-Lima-Hamilton Corp.

Buick Adds German Opel For 1958

FLINT, MICH.—A new addition to the small car field will appear this fall when Buick begins distribution of General Motors' German-made Opel. Several months ago the company announced its decision to market foreign cars in the U. S. by naming Buick as distributor for Opel and Pontiac as distributor for G. M.'s English-made Vauxhall.

The two Opel models to be offered here, beginning in September, are the Olympia Rekord, a two-door sedan, and the Caravan, a two-door station wagon. Both carry four-cylinder, 45-hp engines which provide the economy associated with smaller foreign cars.

Standard equipment on both models will include heater and defroster, red-line speedometer, clock, turn signals and adjustable front seat. Rear seat in the

Opel Olympia Rekord carries a 45-hp engine, features a redesigned body and new suspension system for 1958.

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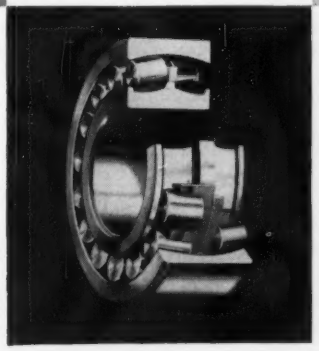

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Make a point to notice the roller end and center guide flange in a Torrington Spherical Roller Bearing. The perfect mating there means a smoother, longer bearing life.

Roller end and flange surfaces alike are ground to a common spherical radius centered on the common vertex of bearing axis and roller axis. Under all load conditions, the rollers bear lightly but constantly against this flange. This guides the roller positively with minimum friction and prevents skewing. Stress concentrations leading to early failure are avoided, so the bearing will serve you many good turns longer.

This is the kind of feature Torrington builds into its bearings out of its experience with all major types serving in all kinds of equipment. Care for such details is matched only by our care in mating the *right* bearing to the *right* job. In this, your Torrington representative is an expert: call on him when you need help. *The Torrington Company,* South Bend 21, Ind.—Torrington, Conn.

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Circle 409 on page 19

Caravan folds forward to provide cargo space measuring 6 ft long, 4½ ft wide. A luggage rack mounted on the roof of the Caravan is also standard.

The two Opel models have identical engines of 90.8 cu in. displacement and 6.9 to 1 compression ratio. Wheelbase is 100.04 in., length 174 in., and width 64 in. The Rekord weighs 1995 lb and is 59 in. high; the Caravan weighs 2160 lb and stands at 62 in. high.

First shipment of Opels to the U. S. will be split between the East and West Coasts and will be limited to the Rekord model. In November, when the Caravan becomes available, the distribution will expand.

Newest entry in the U. S. small-car field, the German-made Opel Caravan to be distributed by Buick this fall.

Planning in Final Stages For Mechanisms Conference

CLEVELAND, O.—Final details are being arranged for the Fourth Conference on Mechanisms to be held at Purdue University Oct. 14 and 15. Believed to be the only organized meeting of its kind, the Conference is devoted to methods and systems for the design and development of mechanisms; practical applications and uses of cams, linkages and gearing; and production considerations and limitations.

A select program of ten papers will be presented by outstanding mechanism specialists during the forthcoming two-day session. This represents the largest and most comprehensive program in Conference history and points to the continuing growth and interest enjoyed by the Conference since its conception four years ago.

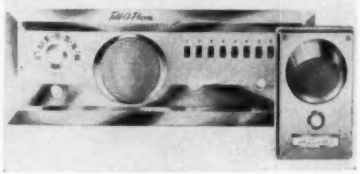
A feature of this year's program will be a presentation by Dr. Richard W. Wallen at the Conference banquet, Monday evening, Oct. 14.

Dr. Wallen is a noted industrial and clinical psychologist. While the Conference deals with design of mechanisms, Dr. Wallen deals with techniques and fundamentals that determine creative processes and make design possible. His timely subject is directed toward organizational policy and personnel relationships which help build a creative group of people. It involves both an analysis of thought processes and analysis of the environment in which people work. Dr. Wallen received degrees at Ohio State University, has long experience as an industrial consultant, and has published a number of papers for professional journals. At the present time he is senior associate of Creelman Associates, Cleveland.

Abstracts of each technical paper, together with author biography appeared in the last issue (Sept. 5) of MACHINE DESIGN. Complete program details with an advanced registration and room reservation form appear on Page 86 of this issue.

For any additional information, write to Editor, MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio.

HOLES WHERE YOU WANT THEM will be located more easily and accurately with this skid-mounted boring unit adaptable to many truck makes and models. Fingertip-controlled hydraulic positioning enables operator to move bore as much as 22 in. beyond truck platform and to traverse the bore on a radius of 80 in. max about a center on the platform. Arrangement reduces maneuvering of the truck, enables shifting the bore if it encounters an obstacle. The unit is made by Highway Trailer Co. and is named Spotter-Base.



ALL-TRANSISTOR intercom-radio system for the home is announced by Talk-A-Phone Co. The system consumes less electricity than a kitchen clock, and its transistor circuit is claimed to last almost indefinitely.

Jet Flameout Reignited By Platinum Alloy "Pilot Light"

EAST NEWARK, N. J.—Flameout in jet engines may be eliminated by a simple automatic reigniter developed by Charles Engelhard Inc. The device has been made standard equipment on the new Bristol Britannia 102 turbojet airliner.

Intake of small amounts of water or ice, or violent air turbulence as produced by a tight maneuver, can cause a jet engine to lose flame. This can present a hazardous situation, particularly at high altitudes where some engines are not easily restarted. The tailpipe must usually be drained of fuel first, and if reignition is delayed too long the air-fuel mixture may explode instead of burning properly.

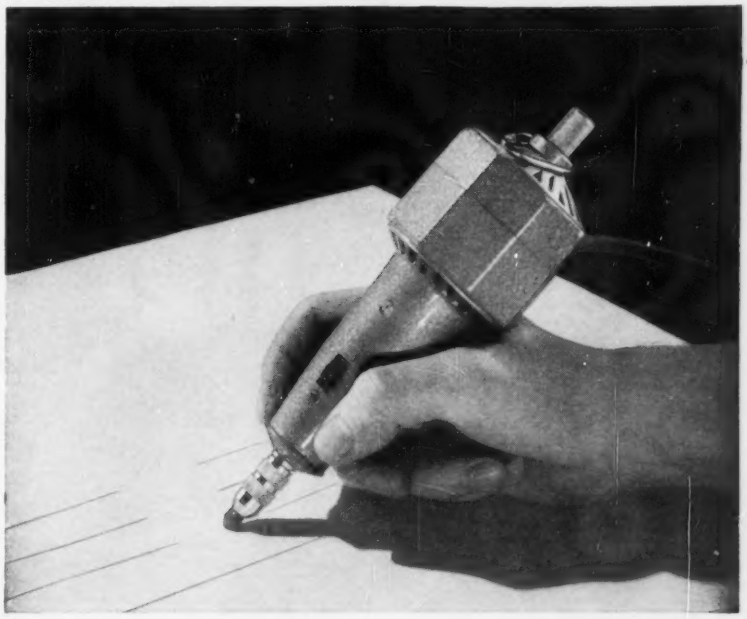
Instant reignition of jet fuel by a small platinum alloy device is claimed to virtually eliminate hazard of engine flameout. New reigniter replaces conventional electrical devices, acts as combustion catalyst.

Engelhard's reigniter is little more than a platinum alloy rod, smaller than a cigarette, mounted in a stainless-steel screw or flange holder. When installed, it protrudes about 2 in. into the engine combustion chamber. Up to four units are mounted in each engine.

The alloy is a catalyst for jet-fuel combustion. It also has high heat retentivity. Kept at combustion temperature by the engine's regular operation, it acts as an

(*Please turn to Page 22*)

DRAFTING TRENDS



New erasing machine for fast, clean, effortless erasures

The idea of erasing machines certainly is not new. However, it wasn't until the Sovereign was developed that so many time-saving and drafting efficiency features were combined into one product.

Distributed by POST, the smooth-running, light weight Sovereign erasing machine can be used as accurately and effortlessly as a pencil point. Even for fine lines, just a dab with an easy-to-handle Sovereign gives a clean, neat erasure without damage to the drawing.

The speed of the rapidly rotating eraser does the work, not pressure. In fact, if too much pressure is used, the machine automatically stalls, thereby safeguarding your drawing. Operation is cool, as the Sovereign definitely will not overheat.

Using a Sovereign is just as easy as reaching for an old fashioned eraser . . . and much more convenient. Curved to fit the hand, it incorporates many design features of special appeal to engineers and draftsmen. For example, the hollow armature shaft takes a full 7" core eraser which feeds through an instantly adjustable chuck. The extra long eraser eliminates those frequent, annoying changes often associated with ordinary erasing machines using short erasers. (When a change is finally made, the chuck cuts replacement time to *less than 10 seconds.*)

The large loop hanger is ideal for hanging the Sovereign within easy reach of the board. Or, if the erasing machine is used frequently, the octagonal shape design permits the draftsman to lay it on the drawing board without fear of it rolling off.

For more information on the Sovereign Erasing Machine, see your POST dealer or write to the Reader Service Division of the Frederick Post Company, 3652 N. Avondale Ave., Chicago 18, Illinois.

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for More Information . . .

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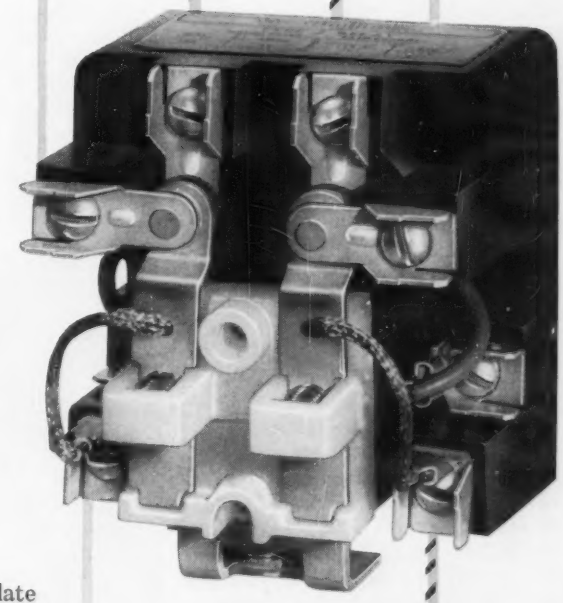
Does A Big Job

Takes Less Space

TYPE Z RELAY

by Westinghouse

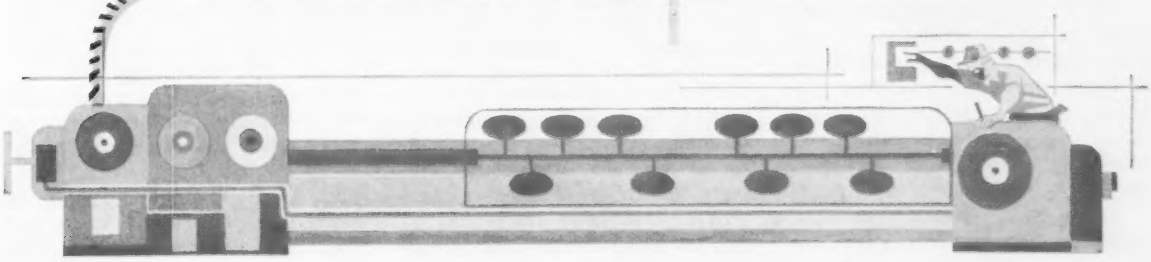
Small, versatile, amazingly rugged, this new Westinghouse 10-amp relay is designed for long life and high reliability. The relay user who has space problems . . . wants a lot of relay in minimum mounting space finds Type Z ideally suited. Type Z meets U. L. Standards for 300 volts, is equipped with double-pole double-throw contacts of fine silver. Coil and core are interchangeable for a-c or d-c operation. An ideal relay for auxiliary multiple-circuit switching of light loads, small motors or for operating larger contactors or starters. J-30262-A



YOU CAN BE SURE... IF IT'S

Westinghouse

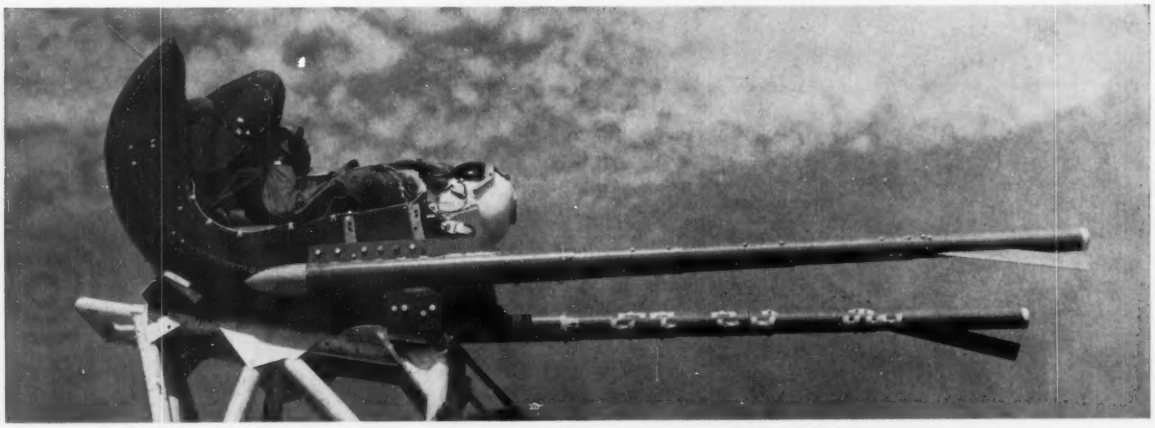
Nylon armature insulating plate
Encapsulated removable coils
Firm contact pressure, low resistance



Circle 412 on page 19

(*Continued from Page* 15)
automatic pilot light when flame-out occurs.

The reigniter is impervious to grain growth despite intense engine heat, and is not poisoned by tetraethyl lead or other jet fuel components. It can ignite heavy and light hydrocarbons with equal facility. These characteristics, plus the absence of electrical circuitry, virtually eliminate maintenance.



OLD CHINESE TRICK of attaching a stick to a skyrocket to make it fly on an even course has been applied successfully in testing of this supersonic ejection seat. Two telescoping booms extending 5 ft beyond the back of the pilot import stability to the rocket-powered seat and prevent tumbling, whirling and yawing gyrations when seat is plunged into the airstream. Before ejection from the aircraft, seat and pilot would be raised out of the cockpit by an explosive charge and rotated 90 deg into a supine position by a scissors mounting mechanism. Booms would be extended by an internal powder charge, followed by automatic ignition of a rocket engine that launches the seat away from the aircraft. Convair Div. of General Dynamics Corp. is chairman of a 13-member committee of aircraft companies working to perfect a fast, safe ejection seat.

Woven Teflon, Glass Suited As Multimotion Bearing Liner

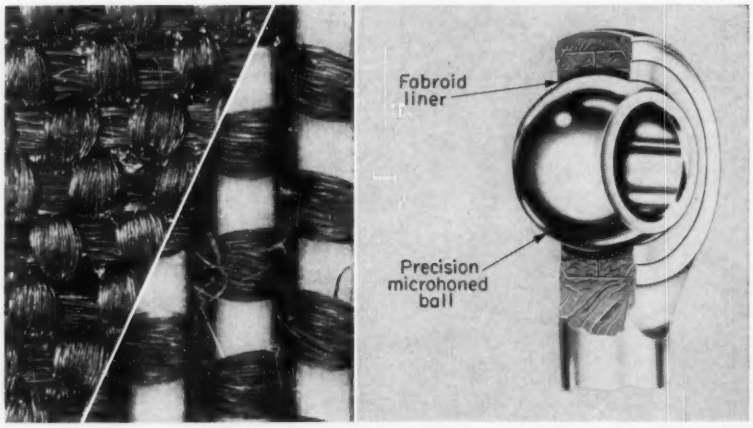
Enable High Load, Long Life, No Metal-to-Metal Contact

EVANSTON, ILLINOIS — Bearings of woven Teflon, particularly suitable in self-aligning and rod-end applications, have demonstrated the ability to support static loads up to 60,000 psi. Extended service life, up to ten times that of metal-to-metal bearings, is also claimed. The plastic bearings, called Fabroid, have been developed by the Micro - Precision Div., Micromatic Hone Corp.

The Fabroid bearing is a composite structure consisting of two fused layers bonded and cured at elevated pressures and temperatures. A dense lattice of Teflon fibers facing the bearing surface is intimately supported by an interlinked glass-phenolic structure.

Under load, Fabroid presents properties different from any other known form of Teflon. Intimate contact between the two bearing surfaces causes the strands of Teflon to interlock. This action prevents the Teflon from extruding.

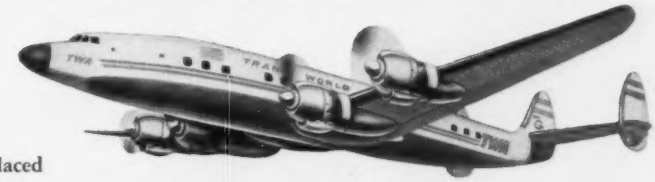
In a self-aligning bearing or rod end, the Fabroid liner is preformed by a drawing operation and bonded to the inside of retainers. A pair of two retainers are then assembled around the ball and pressed into the outer ring of the bearing or into the body of the rod end. A lip is spun on the outside



Fabroid bearing is a composite structure of two fused layers, seen magnified here. Bearing face is a weave of Teflon fibers, left, interwoven on the back with glass fibers, right. The back-up layer is a weave of glass fibers impregnated with thermosetting phenolic. The two prevent metal contact.

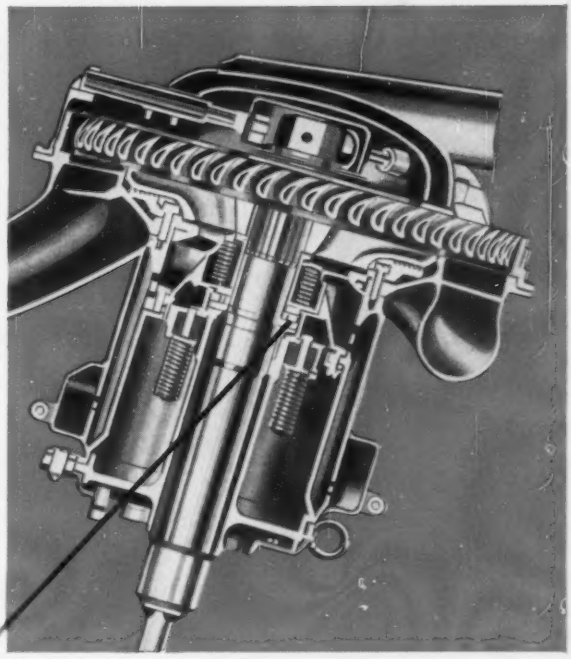
GRAPHITAR® OIL SEALS PLAY

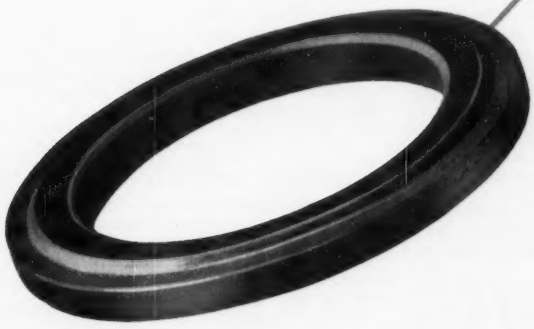
IMPORTANT PART IN DEPENDABLE PERFORMANCE OF NEW POWERFUL CURTISS-WRIGHT TURBO COMPOUND ENGINES



Increased demands for faster non-stop service has placed great demands on the engines that power modern airliners. Helping to meet this need is the powerful EA Series Turbo Compound engines built by the Wright Aeronautical Division of the Curtiss-Wright Corporation, Wood-Ridge, New Jersey. In each of these 18-cylinder giant engines, 3 GRAPHITAR oil seals play an important part in maintaining the dependability, efficiency and power. Three power-recovery units are employed on the Turbo Compound to utilize normally wasted exhaust gases and provide still additional thrust. The GRAPHITAR seals are used on the turbine shaft in each of these units and must withstand continuous high speeds and high temperatures. These seals prevent hot gases from reaching the shaft bearings and carbonizing the lubricant. Low coefficient of friction, and the excellent wear and sealing properties of GRAPHITAR make it ideally suited for this demanding installation.

Compacted under extreme pressure, and fused at heats to 4500° F., GRAPHITAR can be formed into relatively complex shapes, ground to tolerances as close as .0005". Since it is entirely self-lubricating, GRAPHITAR can be used where only steam or water are present. GRAPHITAR is lightweight, durable, chemically inert and virtually unaffected by extremes of vibration, pressure, or temperature.





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R-248-1

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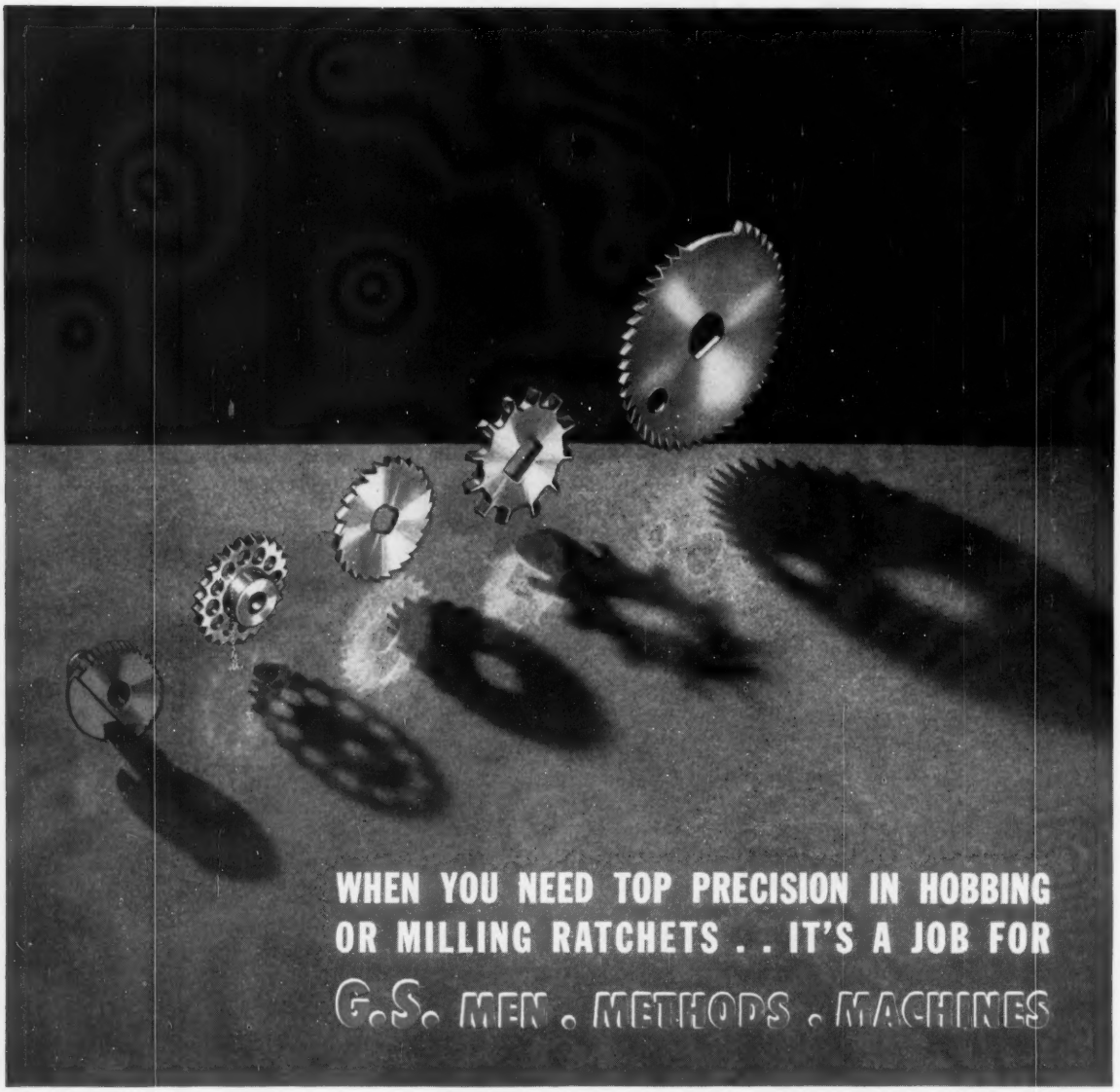
DIVISION OF THE WICKES CORPORATION, SAGINAW 7, MICHIGAN

GRAPHITAR® CARBON-GRAPHITE • GRAMIX® SINTERED METAL PARTS • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES

Circle 413 on page 19



FRACTIONAL HORSEPOWER GEARING

GEAR Specialties, Inc.

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Here at G.S., Hobbing, Shaping and Milling of Ratchets is a unique specialty. Years of testing, developing and perfecting men, methods and machines, has resulted in a degree of uniform accuracy, far greater *and more consistently dependable,* than you ever thought possible!

Over the years, G.S. customers have benefited substantially from our ability to maintain such extreme accuracy, in *every unit we ship!* Think of the savings in costly downtime, in rejects, in returned goods. And, think of the increased service and satisfaction of a smoother, quieter, longer-lasting product.

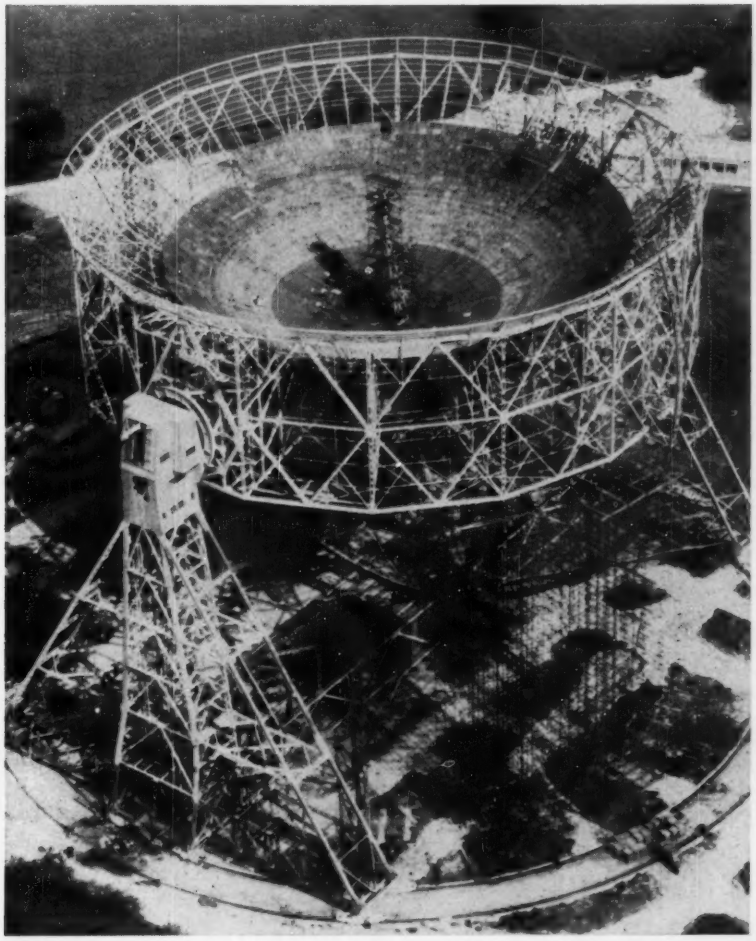
Should YOUR requirements call for hundreds or thousands of Cams, Ratchets or Small Gearing of any description, from 8 to 96 d.p., from 1/8" to 8" diameters, it's a job you'll like better if it's done by G.S. Send drawings and descriptions today. Let our skilled engineers help you. Ideas, suggestions and moderate cost estimates do not obligate you.

SEND FOR..

G. S. technical data, free! See where and how we mass-manufacture Small Gearing to uniformly fine tolerances. Folder contains 23 pictures of Small Gears, plant view, as well as Diametral and Circular Pitch Tables. Ask for your copy on company stationery, please!

41 Years of Specializing in Small Gearing!

Circle 414 on page 19



WORLD'S LARGEST RADIO TELESCOPE, consisting of the world's most sensitive radio receiver and most far-reaching transmitter, nears completion at Jodrell Bank, Cheshire County, England. Manchester University will use the lensless telescope to probe 1000 million light years into space, several times the capability of any existing visual telescopes. The parabolic reflector, constructed of sheet steel, is 250 ft in diameter, weighs 750 tons. Telescope rotates vertically on machinery taken from battleship gun turrets. The entire structure, weighing 2000 tons, rotates horizontally on steel rails. In design of the driving system, scientists resorted to wind tunnel tests to determine forces likely to act on the large parabolic surface in any foreseeable weather.

of each retainer and the assembly is cured at high temperature and pressure.

In effect, the Teflon face of the Fabroid liner coats the outside of the ball so that in service the relative movement is between two Teflon surfaces rather than between Teflon and metal. The coefficient of friction within normal ranges of surface speeds and unit pressures is as low as 0.01. In the range of temperatures from −65 to 400 F, coefficient of friction does not exceed 0.04.

Even if subjected to overloads or contaminated atmospheres, it is claimed that Fabroid bearings will not gall or seize. This ability is due to the fact that Fabroid liners maintain a certain e'asticity so that intimate contact between bearing surfaces is maintained. Abrasive particles which get into the clearance between bearing faces are imbedded in the soft plastic.

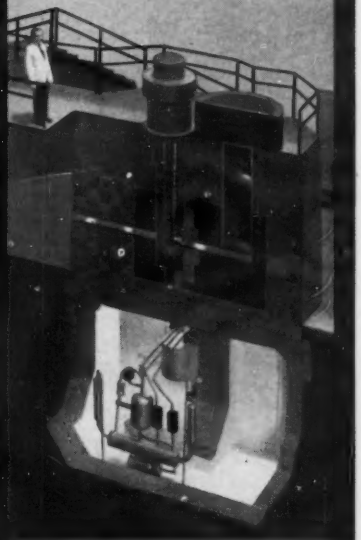
Do you think of pressure transducers?

AI

ATOMICS INTERNATIONAL

DIVISION OF NORTH AMERICAN AVIATION, INC.

does... and uses Statham pressure transducers as part of the control instrumentation in the construction of its nuclear reactors which open entirely new fields in industrial research and development by providing an on-the-spot source of high-energy gamma rays and neutrons.



WHEN THE NEED IS TO KNOW... FOR SURE SPECIFY STATHAM

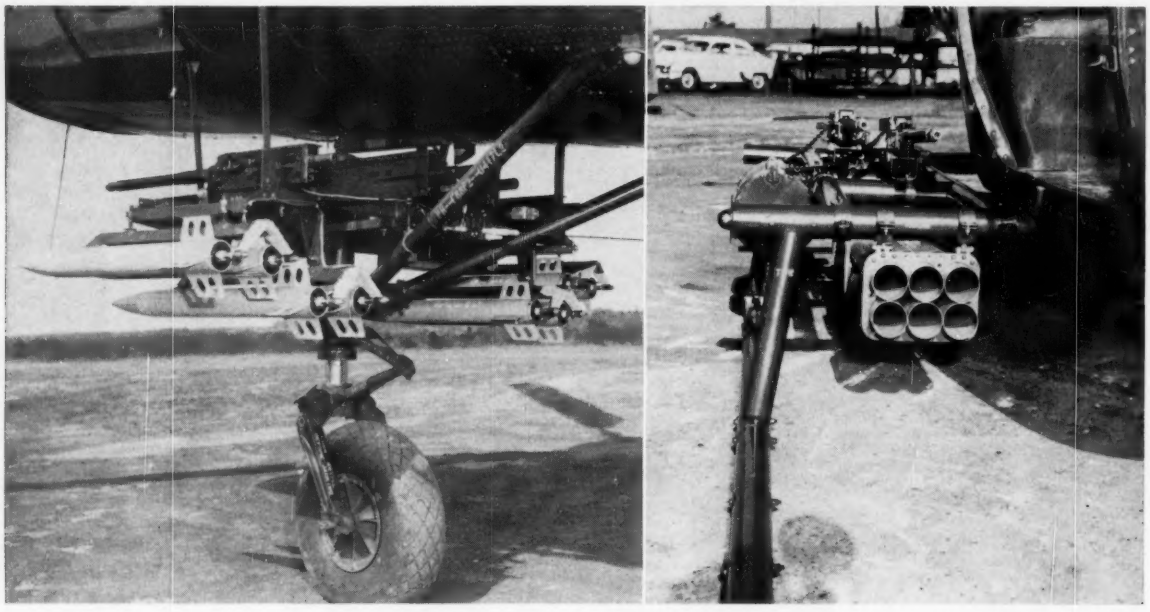
Accelerometers
Pressure Transducers
Load Cells

Catalog, complete with prices, available upon request.

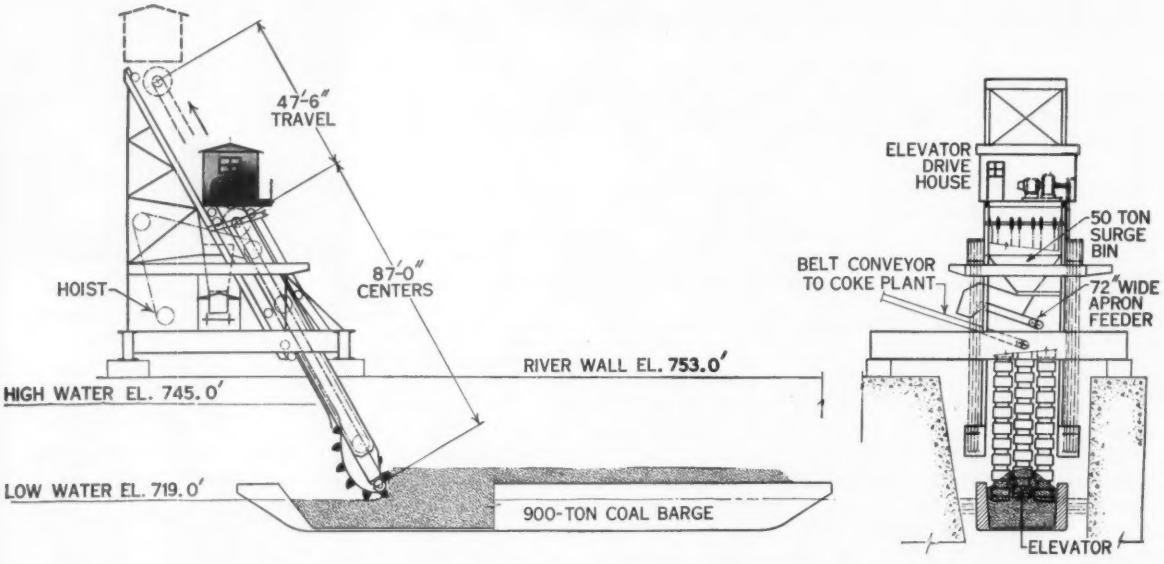
Statham LABORATORIES

LOS ANGELES 64, CALIFORNIA

Circle 415 on page 19



SKY CAVALRY is the Army's designation for a platoon of rocket-armed helicopters under evaluation at the Fort Rucker Aviation School. The helicopter provides a unique aerial platform for shooting at enemy troops, tanks and vehicles. Its vulnerability is protected by low-level flights and extreme maneuverability. Flying at tree-top level it can appear suddenly, fire, and quickly seek safety of favorable terrain. Since helicopters do not provide large sources of electrical and hydraulic power, installation of weapons and controls has been a major problem. In addition, rockets for high-speed aircraft do not have the same accuracy with helicopters, and recoil forces are not compatible, since helicopters are sensitive to trunnion reactions. Armament shown here consists of rockets and machine guns scavenged by the Army from various service branches.



BIG SCOOP continuous barge unloader empties 900-ton river coal barge in less than 30 minutes. This performance makes it the world's fastest of its type, according to its builder, Link-Belt Co. Working elements are bathtub-size buckets, each of ½-ton capacity, on three endless belts. Sliding boom carries the belts into a barge, adjusts to river level and barge's changing freeboard. Barge is emptied in two passes. Big Scoop works for U. S. Steel at the Clairton Works coke plant, southeast of Pittsburgh. It feeds a total of 1567 coke ovens.

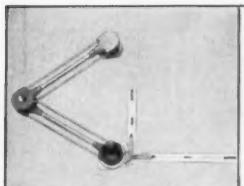
FROM BRUNING – Your One Convenient Source for All Drafting Needs...

5 Wonderful Time-and-Work Savers!

The right tool or material for the job, whether it is a large or small item, means a lot in drafting! That's why the outstanding drafting aids featured here are important to you. That's why they are important members of Bruning's complete quality line. Try them: you will be mighty pleased at how fast the savings of time and labor mount up!

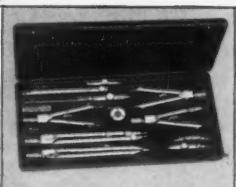
BRUNING ELECTRIC ERASING MACHINE

Make faster, neater, safer erasures with the only electric eraser that gives you all these *plus* advantages: a light, die-cast body that's contour-shaped for comfort (no sharp edges, no finger-cramping design); a quick, snap-action chuck that's easy to use (no bothersome, time-consuming twisting or turning necessary); first-quality sealed bearings that practically eliminate friction heat and wear . . . assuring you of longer, cooler, trouble-free performance that's unsurpassed. Hollow-shaft design—developed and perfected by Bruning—permits use of extra-long, 7-inch erasers for greater safety, speed, convenience, and economy. Five grades of erasers available for every erasing need.



BRUNING "VARSITY" DRAFTER

Costs a few dollars more than conventional T-Square, triangle, and protractor; lets you make neater, more accurate drawings . . . up to 25% faster. Full circle protractor and indexing clamp permit scales to be set quickly and precisely to any desired angle. For drawings to 24"x30". Ideal for shop drawings, home use, students.

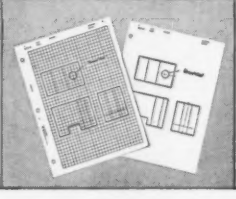


"WILD" STAINLESS STEEL INSTRUMENTS

Now, get the higher precision, lifetime durability and beauty offered only by the instruments made entirely of stainless steel. They will not oxidize, can not be damaged by perspiration. Specially hardened, swivel-type pen nibs are exceptionally durable, easy to clean. Swiss precision-made. Moderately priced. Handsome metal cases.

"VISI-VEL" TRACING PAPER

This wonderful new resin-transparentized tracing paper offers up to 25% faster reproduction speed, unsurpassed toughness, durability, and permanence. Accepts pencils as hard as 9H, and areas can be erased repeatedly without damage to drawing qualities. Rolls or sheets. Thin, medium, heavy weights



No. 697 H "GRID-X" CROSS SECTION PADS

This handy, time-saving cross section pad lets you draw to scale. . . make sharp copies without cross section lines. Cross section lines are printed in light blue, will not reproduce. Pads are available with or without pre-printed heading containing fill-in blanks for basic data. Cross sections come 4x4, 5x5, 8x8, 10x10 squares per inch.

Take a minute now to mail the coupon. Save yourself hours of time and work later on.

BRUNING

Offices in 38 Cities of the U.S. and Canada

CHARLES BRUNING COMPANY, INC., 4700 MONTROSE AVE., CHICAGO 41, ILL.

In Canada: Charles Bruning Company (Canada) Ltd., 105 Church Street, Toronto 1, Ontario

Charles Bruning Company, Inc., Dept. 94-K
4700 Montrose Ave., Chicago 41, Illinois

Please send me information on these Time-and-Work Savers:

☐ Electric Erasing Machine ☐ "Varsity" Drafter ☐ "Wild" Instruments
☐ "Visi-Vel" Tracing Paper ☐ Cross Section Pad

Name_____ Title_____

Company_____

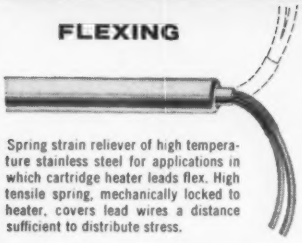
Address_____

City_____ County_____ State_____

TAKE YOUR PICK!

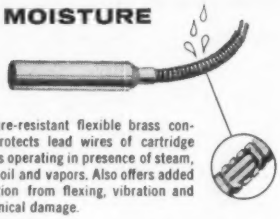
Special Chromalox features solve 3 spot heating problems

FLEXING



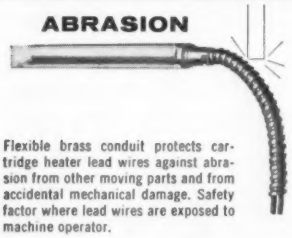
Spring strain reliever of high temperature stainless steel for applications in which cartridge heater leads flex. High tensile spring, mechanically locked to heater, covers lead wires a distance sufficient to distribute stress.

MOISTURE



Moisture-resistant flexible brass conduit protects lead wires of cartridge heaters operating in presence of steam, water, oil and vapors. Also offers added protection from flexing, vibration and mechanical damage.

ABRASION



Flexible brass conduit protects cartridge heater lead wires against abrasion from other moving parts and from accidental mechanical damage. Safety factor where lead wires are exposed to machine operator.

FREE BULLETIN!

CHROMALOX ELECTRIC CARTRIDGE HEATERS

Get the full story. Call your Chromalox Representative or write today for Bulletin 850.

C-2101

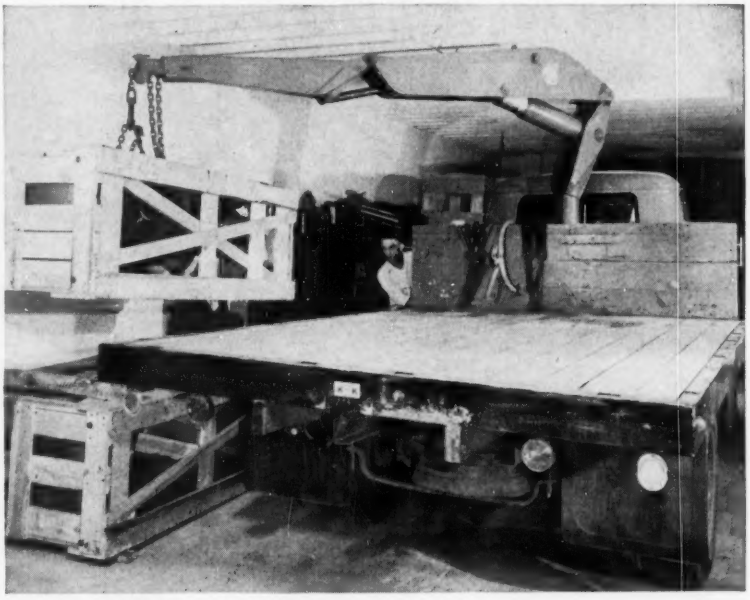
Edwin L. Wiegand Company

7575 Thomas Boulevard • Pittsburgh 8, Pa.

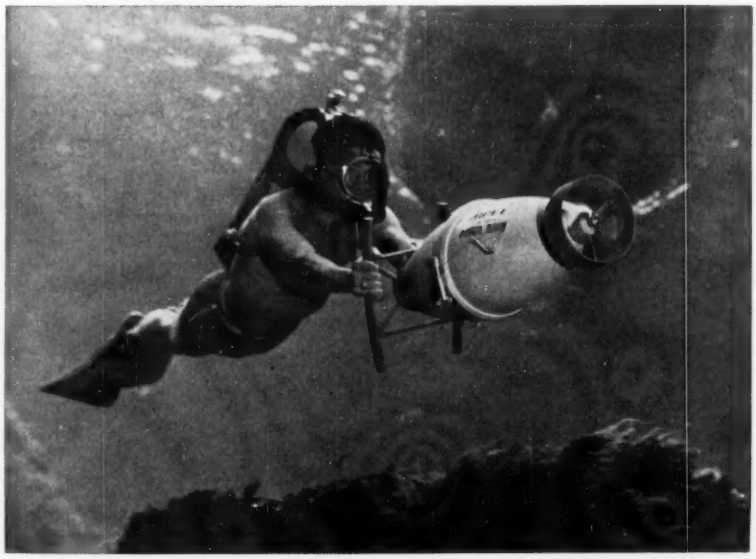
CHROMALOX

Circle 417 on page 19

Engineering News Roundup



CONVERTIBLE CRANE folds into a 15-in. space behind truck cab when not in use, leaving the entire truck bed clear for cargo. Lifting capacity ranges from 6000 lb on shortened boom of 5 ft, to 2500 lb on extended boom of 13 ft. Boom is hydraulically controlled, will swing in a 360-deg arc. Maximum lifting height is 20 ft above ground level. Hydraulic outriggers to handle heavy loads are provided as standard equipment. Known as the Hiab 170, the unit is made in Sweden, distributed here by Stanco Mfg. & Sales Co. Crane can be one-man operated from either side of cab.



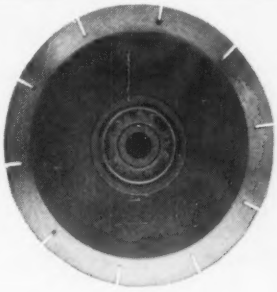
Photo, courtesy of Florida's Silver Springs

MARINE POWER DIVER gives skin divers energy conserving propulsion with finger-tip maneuverability at depths to 180 ft. Manufactured by Bludworth Marine Div., Kearfott Co., the "Power Diver" can also be used as a surface swimming aid and safety device. Power is furnished by 6 or 12-v aircraft-type batteries. Speed, submerged, ranges from 0.9 to 2.2 mph depending on battery size and weight of the diver. The unit weighs $1\frac{1}{2}$ lb submerged; about 70 lb in air. Housing is fiber-glass reinforced plastic.

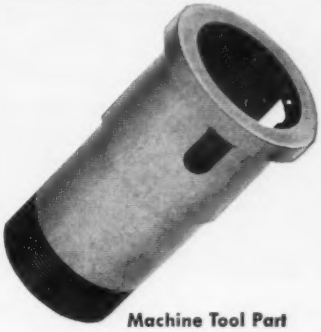
Aircraft Torque Wrench

Split Bearing Race

Pump Part



Slitter Knife



Machine Tool Part

Collet

For tricky shapes like these...

Steel that's hard and tough but easy to machine

PARTS like slitter knives, collets, split bearing races and the others shown above have to be hard and tough. But because of their intricate shapes, they have to be made of a steel that's easy to machine. This combination of toughness and machinability isn't easy to find. But you get it in Timken® 52100 steel.

Timken 52100 steel has a fully spheroidized structure that makes machining easy—without sacrificing strength or hardenability. It is a high-carbon analysis alloy steel with high fatigue and tensile strength and good hardenability throughout its cross section. Timken 52100 steel withstands working pressures up to 200,000 p.s.i., can be oil quenched to a maximum hardness of 65/66 Rockwell C in normal sections. And you can be sure of uniform quality in every shipment of Timken 52100 steel, because the Timken Company controls quality through every production step, from furnace to final inspection.

The Timken Company pioneered the production of 52100 steel tubing in the U. S. We're one of the world's largest producers of this hard, tough steel and the *only* source of 52100 steel in three finished forms—bars, tubing and wire. For small run or emergency requirements, we maintain a mill stock of 52100 tubing, in 101 sizes ranging from 1″ to 10½″ O.D. Write for a complete stock list of available sizes, grades and finishes. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable: "TIMROSCO".

TIMKEN *Fine Alloy* STEEL

TRADE-MARK REG. U. S. PAT. OFF.

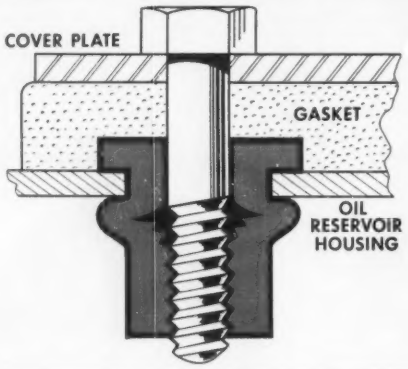
SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS STEEL TUBING

See the first Timken Televent hour, in color, "Eleven against the ice—story of the Antarctica Turnpike". NBC-TV, Monday night, Sept. 23.

Circle 418 on page 19

B.F.Goodrich Rivnuts

cut assembly time and costs by 50%



ELIMINATE WELDING, TAPPING AND CLEANING

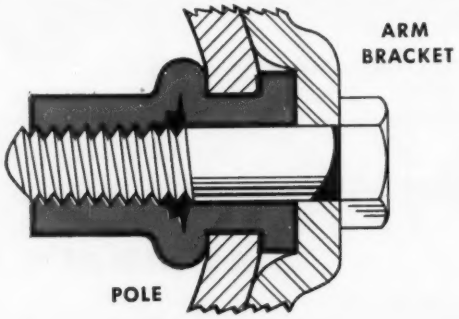
A fastening job on oil reservoir housings formerly took 5 operations. First the housings had to be detoured from the assembly line. Then nutplates were welded on the inside, drilled, tapped and cleaned before the covers could be attached.

By switching to B. F. Goodrich Rivnuts, this whole job is now done in half the time. Rivnuts are installed by one man from one side, in seconds. They provide firm, accurate nutplates with six clean threads for fastening. Flow of assembly is uninterrupted.

ONE MAN NOW DOES THE WORK OF TWO

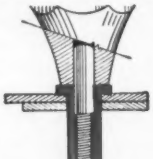
Using conventional nuts and bolts, it took two men to fasten the arm bracket on street light poles. Now, with B. F. Goodrich Rivnuts, one man does this work in the same amount of time.

In the factory, one worker installs Rivnuts in the aluminum poles simply, quickly. The assembler in the field merely lines up the brackets, slips the attachment bolts into position and tightens them. As for strength, tests show that the pole or arm bracket will fail before the Rivnuts.

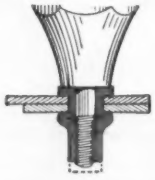


Rivnuts provide at least 6 clean threads in one simple operation!

1 Rivnut is threaded onto pull-up stud of a manual or pneumatic heading tool.



2 Rivnut is inserted—head firmly against work—tool at right angles to work.

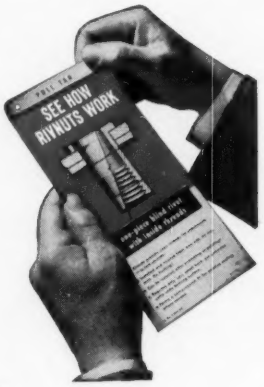


3 Tool lever operates pull-up stud, forming a bulge in the Rivnut shank.

4 After upset, Rivnut threads are still clean and intact ready for screw attachment.

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how Rivnuts fasten *to* and *with*. Explains construction, gives proved applications. Write to *B. F. Goodrich Rivnuts, Department MD-97, Akron, Ohio.*



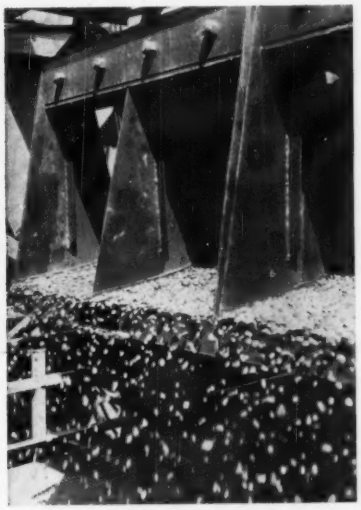
B.F.Goodrich

AVIATION PRODUCTS

a division of The B. F. Goodrich Company, Akron, Ohio

Circle 419 on page 19

SABRE LINER is North American version of utility plane based on military specifications. Two General Electric J-85 turbo-jet engines mounted aft the wing enable speeds around 500 mph. At cruising altitude of 45,000 ft, Sabre Liner will cross half of U. S. on one fuel load. First flights, next year.



BOUNCING STONES segregate themselves according to hardness in this gravel up-grader developed by Blaw-Knox Corp. A vibratory feeder drops gravel on an inclined impact plate. Bounced stones are collected in separate compartments spaced at varying intervals from the impact plate, with stones of similar composition landing in the same bins. By up-grading low quality gravel often available at job sites, the new process cuts long-distance shipping.

Navy Reschedules Development, Building of New Air Arms

Some Planes Revalued, but Budget Cuts Miss Missiles

WASHINGTON—Changes in future production rates for the continuance of current status of certain new-model aircraft and missiles have been announced by the Navy. Reasons given for the decisions are: Increased costs, technological advances, and budgetary limitations. Aircraft and missiles involved are:

F8U-1 Crusader—Chance Vought fighter. Small reduction in current procurement; related slowdown in planned production rate.

F4D-1 Skyray—Douglas fighter. Program unchanged except for schedule stretchout.

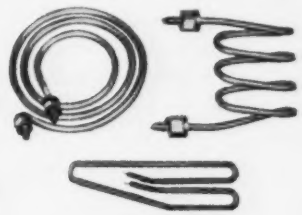
A3D Skywarrior—Douglas attack bomber. Modifications of the basic A3D are now being produced at the previously planned rate. First flight tests are expected early next year.

A4D-2 Skyhawk—Douglas attack bomber. Curtailment and accompanying slowdown and stretchout of deliveries.

(*Please turn to Page* 34)

When to specify

VULCAN ELECTRIC TUBULAR HEATERS



1. When application is for: Considerable heat — confined space. Straight or formed in variety of shapes for liquid, gas or metal heating applications. For casting into iron or aluminum. With threaded fittings for liquid immersion heating (water, oil, etc.).

2. When specifications call for: Length — 10″ to 148″; diameter — .250″, .280″, .333″, .450″; wattage — 10 to 10,000 (or higher); voltage — standard 115 or 230, special 6 to 440; sheaths — copper, steel, high temperature alloys.

3. When you have "hot" problems: Vulcan Engineers are ready to provide special heating units — engineered to your needs.

***NEW* FINNED TUBULAR HEATERS**

Vulcan's new Finned Tubular Heaters provide six times as much radiating surface as standard tubular heaters. Fin is spirally edge wound from continuous strip of steel, then silver brazed to surface of sheath. Heaters can be formed at factory into one or a series of hairpin bends.

Write for free catalog.

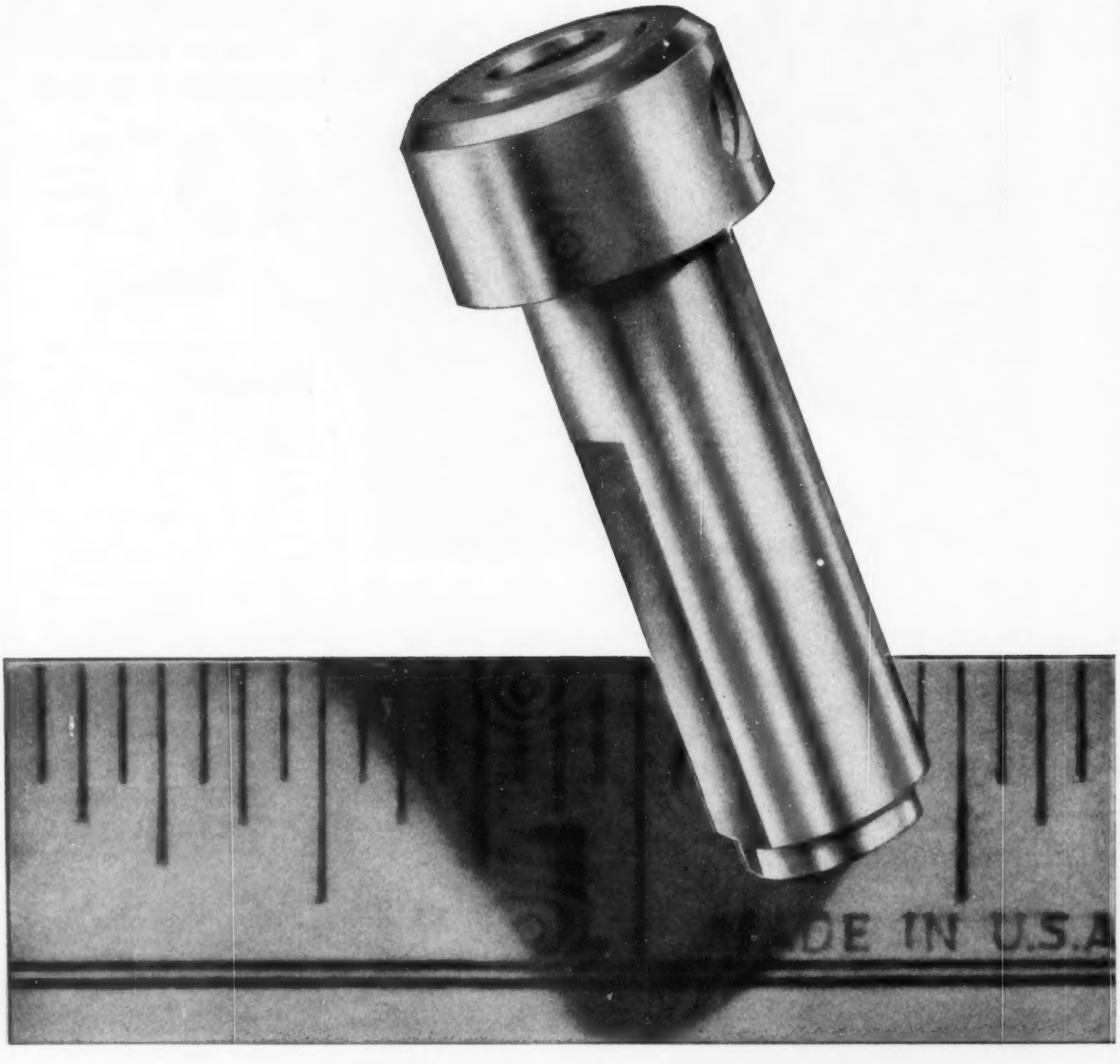
VULCAN

ELECTRIC COMPANY

DANVERS 6, MASS.

Cartridge • Strip • Tubular • Immersion Electric Heaters • Soldering and Branding Irons Solder and Glue Pots

Circle 420 on page 19



MINNEAPOLIS-HONEYWELL

SAVED $2,350 ANNUALLY

on one part alone when they

SWITCHED TO ALCOA ALUMINUM* SCREW MACHINE STOCK

Mr. Len Mayeron, Chief of Components and Materials Section for Minneapolis-Honeywell, says, "This hub used to be made of cold-finished, free-cutting steel. It was switched to 2011-T3 Alcoa Aluminum Screw Machine Stock and now saves $2,350 annually. Even though steel costs less than aluminum, in this particular situation, savings in machining and scrap salvage more than offset the initial material cost."

If you machine parts from steel or brass, now is the time to take a hard look at these economic facts about aluminum:

1. Aluminum costs less than brass, and machines just as fast.
2. Aluminum machines faster than steel and won't rust.
3. Aluminum scrap allowance is high.

Now is the time to switch to Alcoa® Aluminum. To help you make that switch, call on your nearest Alcoa sales office. For immediate delivery of Screw Machine Stock, contact your nearest distributor. ALUMINUM COMPANY OF AMERICA, 873-J Alcoa Building, Pittsburgh 19, Pa.

HERE IS ACTUAL COST COMPARISON OF $2,350 SAVINGS ON THIS PART

Steel Cost per 1,000 parts:

78.5 lbs @ 11¢ per lb	$ 8.63
Less 64% scrap @ 1.1¢ per lb	.55
Net cost	$ 8.08 per 1,000

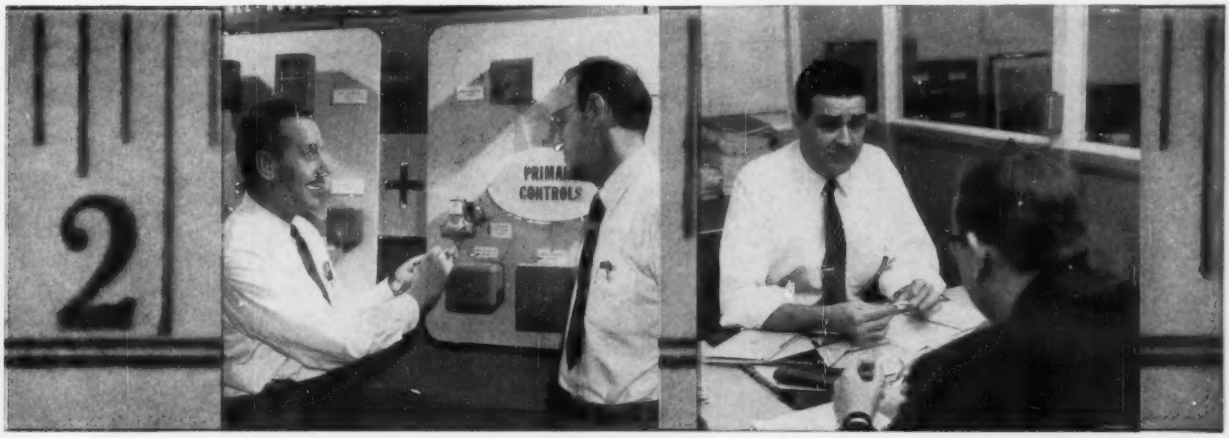
Aluminum Cost per 1,000 parts:

27 lbs @ 65¢ per lb	$17.55
Less 64% scrap @ 14¢ per lb	2.42
Net cost	$15.13 per 1,000

Steel machine time 7.86 hours per 1,000 parts.
Aluminum machine time 2.60 hours per 1,000 parts.

Labor savings 5.26 hours @ 2.265¢	$11.91
Less difference in material	7.05
Net savings per 1,000 parts	$ 4.86

Annual savings on this single-part total $2,350



IN ENGINEERING, Len Mayeron (Right), Chief of Components and Materials Section, discusses cost reduction with John Kriechbaum, Chief of Design and Development Department. Mr. Mayeron says, "We like Alcoa's technical literature and the way they pitch in and help us with production problems."

IN PURCHASING, Bill Smisek, Assistant Purchasing Agent, says, "Alcoa always meets metallurgical specifications. I seldom have had to reject their material. In emergencies, Alcoa seems to be able to find us extra quantities and give us faster than normal deliveries."

✻ LEARN WHY OTHER COMPANIES HAVE SWITCHED TO ALCOA ALUMINUM

Your Guide to the Best in Aluminum Value

WE CHOSE
ALCOA
ALUMINUM
SCREW MACHINE STOCK
ALUMINUM COMPANY OF AMERICA

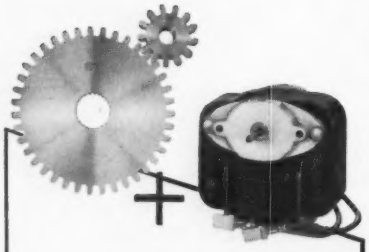
THE ALCOA HOUR—Television's Finest Live Drama, Alternate Sunday Evenings.

Direct quotes from leaders in industry on why they buy from Alcoa.

Fill out coupon for your copy.

Name_____
Title_____
Company_____
Address_____
City_____ State_____

Circle 421 on page 19



Perfect Mating of Gearing and Motors

in MERKLE-KORFF GEARED MOTORS

makes certain you get

MORE TORQUE PER POUND AND PER DOLLAR

GEARS – 45 years' gear reducer experience is your assurance of rugged, precision hobbed, heat treated *High Efficiency* spur gearing at lowest cost, plus —

MOTORS — *High Output vs Weight,* dependable shaded pole motors, engineered to produce *High Starting Torque,* so important in successful geared motor design, is an unbeatable combination.

Merkle-Korff gear reducer motors have helped many of America's leaders reduce cost while improving their product. We can do the same for you.

From .4 to 300 inch-pounds at 800 to ½ RPM.

Many other speeds and torques above and below this range are available.

Ask for Complete Information

MERKLE-KORFF GEAR CO.

215 N. MORGAN ST., CHICAGO 7, ILL.

Circle 422 on page 19

Engineering News Roundup

(*Continued from Page* 31)

A4D-3 Skyhawk — Douglas improved attack bomber. Contract terminated for four planes.

F9F8T Cougar—Grumman trainer. Will be ordered to fulfill requirements for this type trainer.

F11F-1 Tiger — Grumman fighter. Procurement contract remains unchanged.

S2F-3 Tracker—Grumman carrier-based, anti-submarine plane. Small initial production quantity of this aircraft is planned.

T2V-1 Seastar—Lockheed trainer. Procurement was reduced earlier in the year; no further changes are contemplated.

W2V-1—Lockheed improved long-range, early-warning aircraft. Program has been partially terminated.

P6M-2 Seamaster—Martin patrol bomber. Small downward revision in procurement announced in June. No further reductions contemplated.

F3H-2 Demon—McDonnell fighter. Minor stretchout in delivery schedule.

T2J-1—North American Trainer. Not affected.

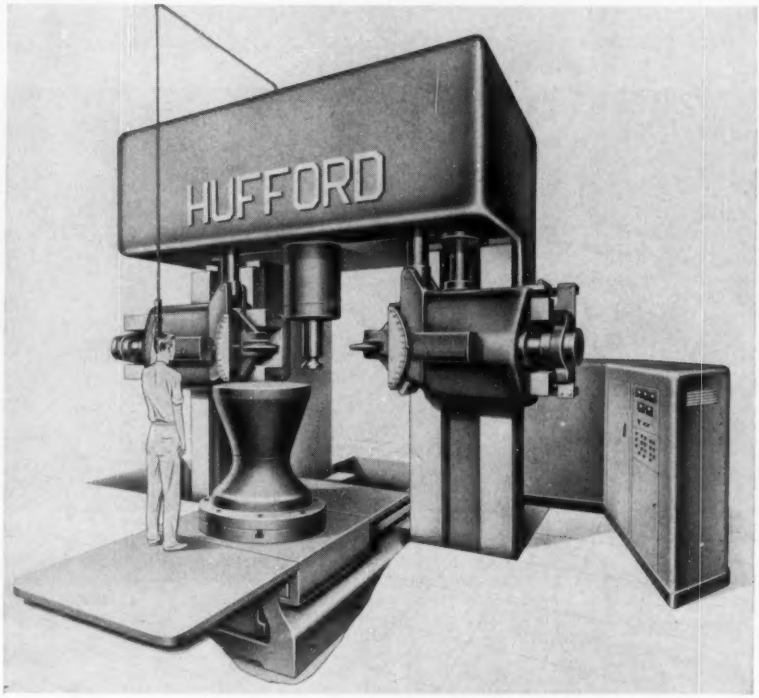
Regulus I and II—Surface-to-surface guided missiles. No changes.

Sparrow I—Air-to-air guided missile. Procurement not affected. Planned production nearing completion.

Sparrow II—Air-to-air guided missile (experimental). Production terminated.

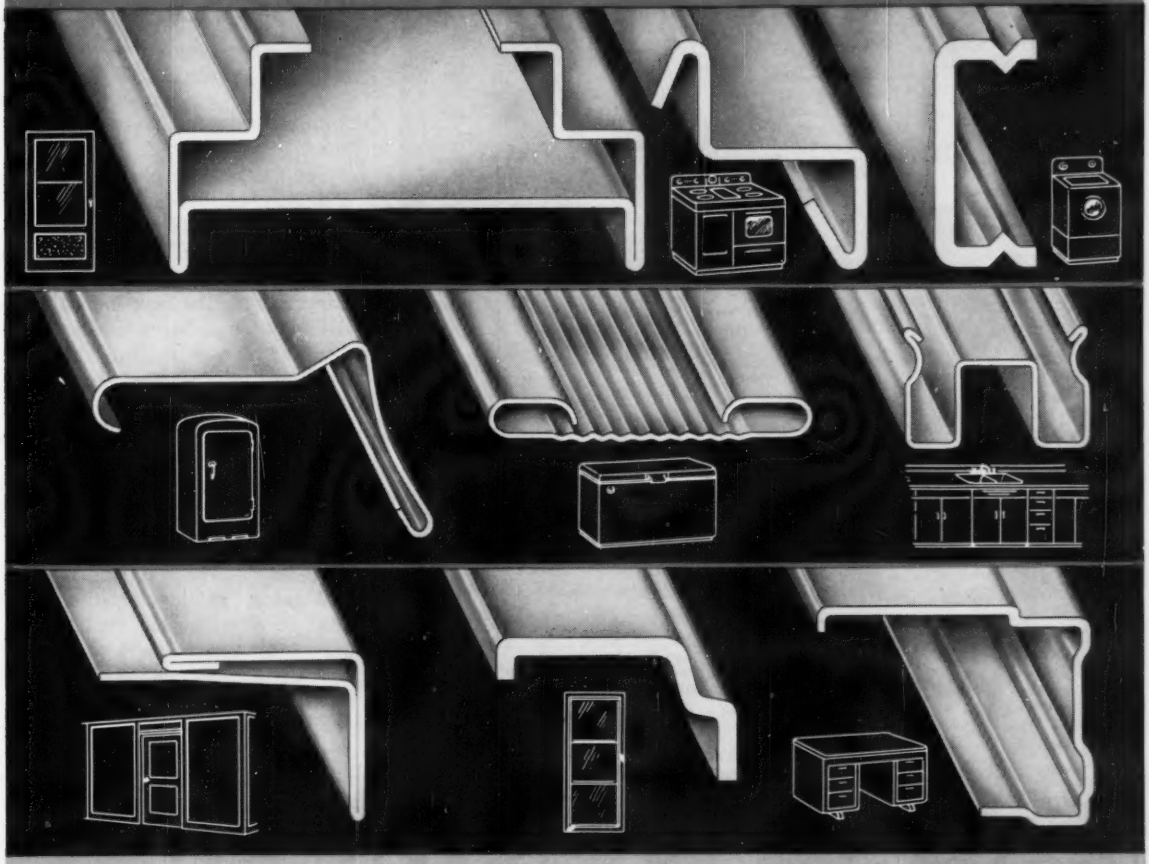
Sparrow III — Air-to-air guided missile. Currently going into production. No planned cutbacks.

Sidewinder—Air-to-air guided missile. No stretchouts or reductions planned.

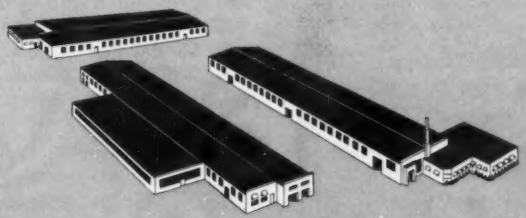


SPIN-FORGE MACHINE combines the features of vertical spinning lathe with a process for forging the wall thickness of sheet parts. Developed by Hufford Corp., the machine forms parabolic, conical, hour-glass and other shapes from a single workpiece. Force for spinning and forging is applied by two opposed rollers, each having a force of 225,000 lb. Rollers feed vertically down the form, longitudinally into die contours, and being mounted on angular tilting heads, follow all contours at a right-angle contact with the work surface. Travel of each roller is controlled independently by templates. Die is mounted on a rotating table having spindle speeds ranging to 400 rpm. Feed rate is 60 in. per minute. The system includes a closed TV circuit for remote observation. Two basic machine types are planned; one for stock 60 in. sq, the other for 120-in. stock.

ROLL FORMED
REDUCES TODAY'S PRODUCTION COSTS



Roll Formed manufactures metal shapes for all industries. We can engineer and produce your shapes and deliver them to meet your production schedules. Because of the accuracy of Roll Formed shapes your finished assemblies will cost you less. We produce simple and complex shapes in carbon, galvanized and stainless steel; aluminum, copper, zinc and clad metals. Uniformity, high production and less scrap hold our costs down. Send your prints and quantity requirements today. Let us show you how you can beat production costs with Roll Formed!



ROLL FORMED PRODUCTS
COMPANY

MAIN OFFICE AND PLANT 3754 OAKWOOD AVE. · YOUNGSTOWN, OHIO

Circle 423 on page 19

Let us take over your inventory problem!

Immediate Delivery

ANY BORE SIZE • ANY MOUNT • ANY STROKE

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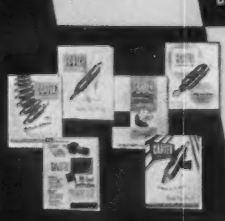
CYLINDERS

Sounds too good to be true, but here's real help for engineers and designers who need fast action on cylinders. Carter's exclusive key type locking design and simplicity of parts *makes it possible to ship cylinder orders in 24 hours or less!* Now you can have rugged, dependable, compact quality cylinders when you want them. We produce around the clock. Your order is in process *minutes after we get it.*

Service on spare parts is good too! Experienced engineers and parts stocks are located in 40 different locations in the U. S., Canada and Mexico.

PHONE SERVICE 24 HOURS A DAY
Orders taken day or night. If you need fast service call your Carter representative or the plant. LANSING, ILLINOIS, GRanite 4-3305 or CHICAGO, BAyport 1-7186. Teletype LNSG, ILL 1119X.



Complete Catalog File!

Complete bound file with ordering details for: Air Cylinders; 750 Lb. Hydraulic; 1500 Lb. Hydraulic; Clamp Cylinders; Air Valves; Built-in Valve Type Cylinders. Complete with parts data, specifications and prices. Send today!

CARTER CONTROLS INCORPORATED
2711 Bernice Road • Lansing, Illinois (Chicago Suburb)

AIR CYLINDERS • HYDRAULIC CYLINDERS • AIR VALVES
ROTARY ACTUATORS • SPECIAL CONTROLS

News Roundup

Carbon Steel Sheet Transformed To Stainless By Diffusion Process

WHITE PLAINS, N. Y.—A new method of producing stainless steel sheet using low-cost carbon steel as a base has been developed by Chromalloy Corp. The resulting product is claimed to withstand operating temperatures of 1500 F, and may be used to replace solid stainless in a number of applications.

The Chromalloy process involves diffusion of chromium into the surface of steel, where an iron and chromium atom exchange takes place, forming a stainless surface integral with the base metal. Since the high-temperature treatment is followed by slow cooling, the sheet becomes fully annealed at the same time. The new product is more easily worked than solid stainless steel sheet and can be bent, drawn, staked, formed, spun or welded without peeling or cracking.

Winning entries in the third product development contest conducted by Steel Founders' Society of America will receive cash prizes from $100 to $1000 at the society's 55th fall meeting, Sept. 23-24, in Hot Springs, Va. Colin Carmichael, editor of MACHINE DESIGN and chairman of the SFSA Judges Committee, will preface the actual awards with a review of the winning entries and their portent to the future markets of steel castings.

Fourth Annual Computer Applications Symposium, sponsored by Armour Research Foundation of Illinois Institute of Technology, will be held Oct. 24 and 25 at the Morrison Hotel, Chicago.

The program on Friday, Oct. 25, will be devoted to discussions of research and engineering applications. Titles of papers to be presented are:

Digital Computer Simulation of Active Air Defense Systems
Statistical Calculations in Product Development Research
Progress in Computer Applica-

tion to Electrical Machine and System Design

The Solution of Certain Problems in the Study of Fluid Flow

A Dual Use Digital Computer

The Status of Automatic Programming for Scientific Problems

The luncheon address is "How Lazy Can You Get," a discussion of programming learning processes in computers.

Meetings

AND EXPOSITIONS

Oct. 1-5—

Society of Automotive Engineers Inc. Aeronautic Meeting, Aircraft Production Forum and Aircraft Engineering Display to be held at the Ambassador Hotel, Los Angeles. Further information is available from SAE headquarters, 485 Lexington Ave., New York 17, N. Y.

Oct. 7-9—

American Society of Lubrication Engineers—American Society of Mechanical Engineers. Joint Lubrication Conference to be held at the Royal York Hotel, Toronto. Further information can be obtained from ASLE headquarters, 84 E. Randolph St., Chicago 1, Ill.

Oct. 7-9—

Second Conference on Manufacturing Automation to be held at Purdue University, West Lafayette, Ind. Sponsors are Purdue and *Automation* magazine. Further information can be obtained from the Editor, *Automation,* Penton Bldg., Cleveland 13, Ohio.

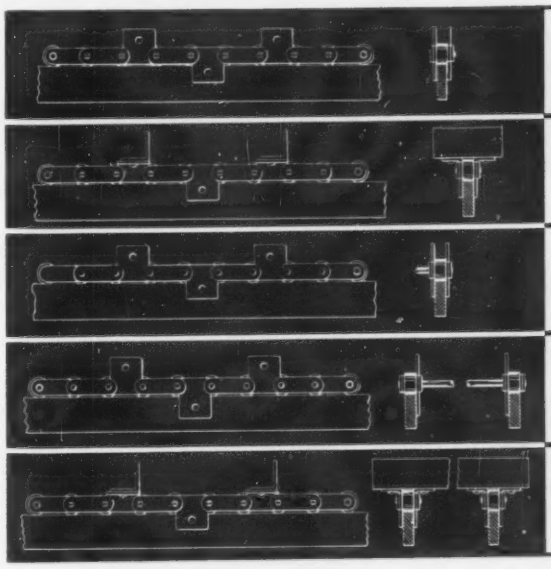
Oct. 7-9—

National Electronics Conference. Annual Meeting and Show to be held at the Sherman Hotel, Chicago. Further information can be obtained from American Institute of Electrical Engineers, 33 W. 39th St., New York 18, N. Y.

(*Please turn to Page* 40)

automation

YOU CAN CUT COSTS BY MOVING YOUR MATERIAL WITH ACME DOUBLE PITCH CONVEYOR CHAINS



No. 1 Single conveyor using standard M35 attachment links

No. 2 Single conveyor using standard K1 attachment links

No. 3 Single conveyor using standard D1 or D3 pin attachments

No. 4 Double conveyor using standard M1 attachments and cross rods

No. 5 Double conveyor using standard K1 attachments

DOUBLE PITCH ROLLER CHAINS

Double pitch conveyor chains, sometimes known as extended pitch chains are becoming increasingly more popular in many industries where high grade finished roller chains are required, at a lower cost than the standard pitch chains. This series was developed on the basis of using standard round parts of the standard series and doubling the pitch. For example double pitch chain #C-2080 which is 2" pitch utilizes the same round parts as 1" pitch heavy series chain #80H.

In addition to being applicable for slower speed power transmission drives these chains are widely used as conveyors for the handling of materials. A standard line of attachments are available that gives this line great versatility in reference to incorporation of cross flights, cross rods, etc., that are applicable for conveyor work.

The double pitch series of chains are widely used in the Agriculture Implement, Baking Machinery, Construction Machinery, Mining, Packaging, Textile industries, etc.

Figure 8 Side Plates, Standard Rollers

Figure 8 Side Plates, Oversize Rollers

Straight Side Plates, Standard Rollers

Straight Side Plates, Oversize Rollers

SPROCKETS

Sprockets for Double Pitch Chains can be furnished in either SINGLE TOOTH FORM OR DOUBLE TOOTH FORM, as shown on the right.

Double tooth cutting actually doubles the life expectancy of the sprocket.

Chain rollers contact only every other tooth. When these teeth become worn after long service, the sprockets can be advanced one tooth, thus permitting chain engagement on a new series of sprocket teeth.

Double pitch chains can be furnished in either Figure 8 or straight side plate type. with standard or oversize rollers.

Single Tooth Cutting

Double Duty Tooth Cutting

FREE CATALOG

Write Dept. 6M for new illustrated 76 page catalog on use and application of roller chains and sprockets.

Acme Chain Corporation

HOLYOKE MASSACHUSETTS

Call ACME for Service

Here's Use

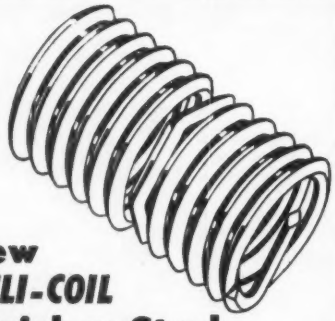
HELI-COIL Stainless Steel Screw-THREAD Insert

This is the insert that permanently protects threads against wear, stripping, corrosion, galling, seizing, vibration and shock. Made of (18-8) stainless steel wire, cold-rolled into a diamond shaped cross-section, this ***Heli-Coil*** Insert is work hardened to a tensile strength of approximately 200,000 psi . . . conforms to military standards MS 122076 through 122275 (ASG) and MS 124651 through 124850 (ASG) . . . conforms to standard commercial and industrial thread forms, including coarse, fine, pipe-thread and MM sizes . . . permits use of standard boss configurations.

Here Are

Save Space, Weight and Costs

Substantial savings in materials, weight, space and costs are possible, as against solid bushings, because smaller (or standard) bosses, flanges and threaded fasteners can be used.



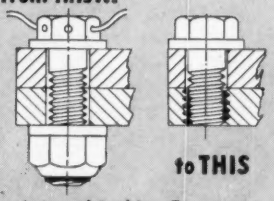
New HELI-COIL Stainless Steel Screw-LOCK Insert

Pat. Pending.

Conforming to military specifications for locking torque and vibration, this notable new ***Heli-Coil*** Screw-LOCK *one-piece* insert provides all the thread protection of the Screw-THREAD Insert, **PLUS** an exclusive internal locking feature that eliminates the need for clumsy protruding lock nuts, lock wiring and other supplementary locking devices . . . saves cost, space and weight . . . permits simplified streamlined design. The Insert is a permanently integrated part of the component—permits repeated service repair disassembly and reassembly, *with locking action remaining unimpaired.* Available in sizes from 4-40 up.

Here Are

from this...

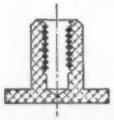


to THIS

Internal Locking Feature

Insures positive internal locking action—eliminates lock nuts, lock wiring and other protruding locking devices—saves space, weight, cost. Yet screw may be easily disassembled with no loss of locking torque.

➡ ***Heli-Coil*** **Field Engineers are at your service for**



CUSTOM LOCK NUTS

The ***Heli-Coil*** Screw-LOCK Insert is adaptable to special-shaped lock nuts, shells, spacers and fasteners and can be engineered to meet your torque or performance requirements. ***Heli-Coil Corporation*** is fully equipped to manufacture these special lock nuts to your specifications.

Note: Custom nuts, with Screw-LOCK Inserts, meet military specifications for lock nuts.

How Design Engineers *HELI-COIL** *INSERTS* to

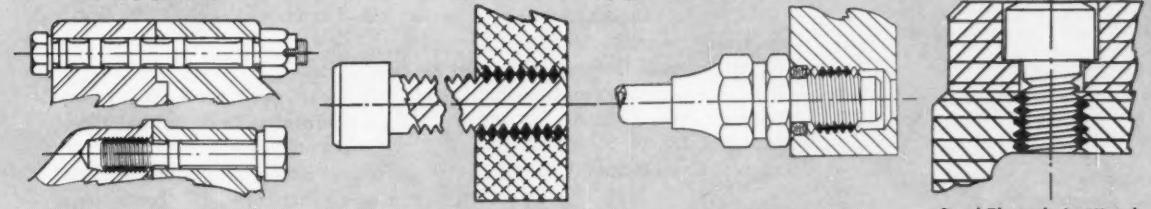
SAVE: SPACE—WEIGHT—COSTS

PERMANENTLY PROTECT THREADS AGAINST

ABUSE • WEAR • CORROSION • STRIPPING • GALLING • SEIZING • VIBRATION

Eliminate Lock Nuts—Lock Wiring—Lock Washers

Some Typical *Heli-Coil* Screw-THREAD Applications



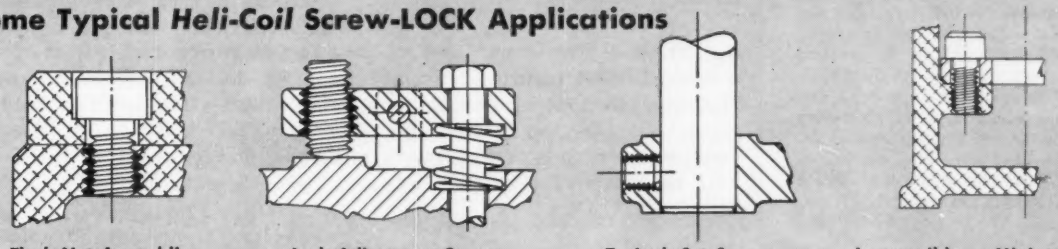
Compact Design
Improves design features by elimination of nuts, washers and extra-length bolts.

Stronger Thread Connections
Under excessive tension, torsion and impact loads in standard proportion bosses, the screw will break but the *Heli-Coil* Screw-THREAD Insert will remain undamaged . . . even in light alloy metal.

Leak-Proof Connections
In lightweight, high pressure hydraulic equipment, stainless steel inserts, regular and pipe thread, protect threaded pump and valve ports sealed with "O" rings.

Steel Threads in Wood, Plastics and Fiberglas
Provides permanent, strong, corrosion-resistant and wearproof threads in soft materials. Especially valuable where frequent assembly and disassembly is necessary.

Some Typical *Heli-Coil* Screw-LOCK Applications



Flush Nut Assemblies
Permits a securely locked, flush assembly, because its internal locking feature eliminates need for drilled head bolts and other protruding locking devices.

Lock Adjustment Screws
This simple design allows permanent, positive adjustment of screws in any position, secure against vibration or impact.

To Lock Set Screws
Positively locks assembly against loosening at desired adjustment—protects threads against stripping under high torque—permits use of light housing materials.

Inaccessible or Miniaturized Assemblies
Heli-Coil Screw-LOCK Insert permits installation of the locking feature from front or top. No blind fumbling for assembly of locking devices inside or behind.

design consultation—without obligation.

HELI-COIL CORPORATION

A Division of Topp Industries, Inc.

*Reg. U.S. Pat. Off.

HELI-COIL CORPORATION
509 Shelter Rock Lane, Danbury, Conn.

Gentlemen: Please send me further information on

- ☐ *Heli-Coil* Screw-THREAD Inserts.
- ☐ *Heli-Coil* Screw-LOCK Inserts.
- ☐ *Heli-Coil* Custom Lock Nuts.
- ☐ Have a *Heli-Coil* Thread Engineer call—without obligation.

NAME_____ TITLE_____

FIRM_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____

In Canada: W. R. WATKINS CO., Ltd., 41 Kipling Ave., S., Toronto 18, Ont.

Circle 426 on page 19

SANTOS DUMONT was NEWS

Santos Dumont was not a place, but a person — from Brazil. He gained a great deal of attention in 1907, when he flew an aeroplane a distance of 235 yards in 21 seconds — carrying a passenger! This historic flight took place in Paris, and was "news" all over the world. Curiously enough, few people at that time were aware of the Wright brothers' history-making flight at Kitty Hawk in 1903; most people then thought of "aviation" as floating about in balloons or dirigibles. It was something you watched at the County Fair — or perhaps at the International Bennett Cup Race.

In this era of scientific and industrial pioneering, our founders Soren Sorensen and John Christensen came west to Cincinnati and started making gears. Cincinnati Gear's beginning was as modest as the aviation industry's; and like the aviation industry, we have grown and progressed significantly in the past fifty years. But one thing has not changed — our old fashioned attention to detail, that insures our gears being 100% *right* every time. It results in a reliability and dependability that our customers like — that *you'll* like too. Why not try us for your next custom gear order?

THE CINCINNATI GEAR CO.
CINCINNATI 27, OHIO
Fifty Years of "Gears—Good Gears Only"

CINTI®

Circle 427 on page 19

Engineering News Roundup

(Continued from Page 37)

Oct. 7-11—

American Institute of Electrical Engineers. Fall General Meeting to be held at the Morrison Hotel, Chicago. Additional information is available from AIEE, 33 W. 39th St., New York 18, N. Y.

Oct. 9-11—

Gray Iron Founders' Society Inc. Annual Meeting to be held at the Drake Hotel, Chicago. Further information can be obtained from society headquarters, National City-E. Sixth Bldg., Cleveland 14, O.

Oct. 9-11—

Society for Experimental Stress Analysis. Annual Meeting to be held at Hotel El Cortez, San Diego, Calif. Further information can be obtained from SESA Secretary-Treasurer, Dr. W. M. Murray, P. O. Box 168, Cambridge 39, Mass.

Oct. 9-11—

Fourth Annual Symposium of High Vacuum Technology to be held at Hotel Somerset, Boston. Sponsor is the Committee on Vacuum Techniques, P. O. Box 1282, Boston 9, Mass.

Oct. 13-17—

Pressed Metal Institute. Annual Executive Meeting to be held in Castle Harbour, Bermuda. Additional information is available from PMI headquarters, 3673 Lee Rd., Cleveland 20, Ohio.

Oct. 14-15—

Fourth Conference on Mechanisms to be held at Purdue University, West Lafayette, Ind. Sponsors are the Purdue School of Mechanical Engineering and MACHINE DESIGN. Additional information can be obtained from the Editor, MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio.

Oct. 16-18—

American Institute of Electrical Engineers. Conference on Computers in Control to be held at the Chalfonte-Haddon Hall Hotel, Atlantic City, N. J. Additional information can be obtained from Prof. J. G. Truxal, Polytechnic Institute of Brooklyn, 99 Livingston St., Brooklyn 1, N. Y.

Oct. 16-18—

Institute of Radio Engineers. Canadian Convention-Exposition to be held in the Automotive Bldg., Exhibition Park, Toronto. Further information can be obtained from IRE headquarters, 1 E. 79th St., New York 21, N. Y.

Oct. 17-18—

Magnesium Association. Annual Convention to be held at the Biltmore Hotel, New York. Additional information can be obtained from association headquarters, 122 E. 42nd St., New York 17, N. Y.

Oct. 17-18—

National Conference on Industrial Hydraulics to be held at Hotel Sherman, Chicago. Sponsors are Armour Research Foundation and Illinois Institute of Technology. Further information is available from Conference Secretary, Armour Research Foundation, 10 W. 35th St., Chicago, Ill.

Oct. 17-19—

National Society of Professional Engineers. Fall Meeting to be held at Grand Pacific Hotel, Bismarck, N. Dak. Further information can be obtained from society headquarters, 2029 K St., N. W., Washington 6, D. C.

Oct. 17-19—

Foundry Equipment Manufacturers Association Inc. Annual Meeting to be held at The Greenbrier, White Sulphur Springs, W. Va. Further information is available from association headquarters, 1 Thomas Circle, Washington 5, D. C.

Oct. 21-23—

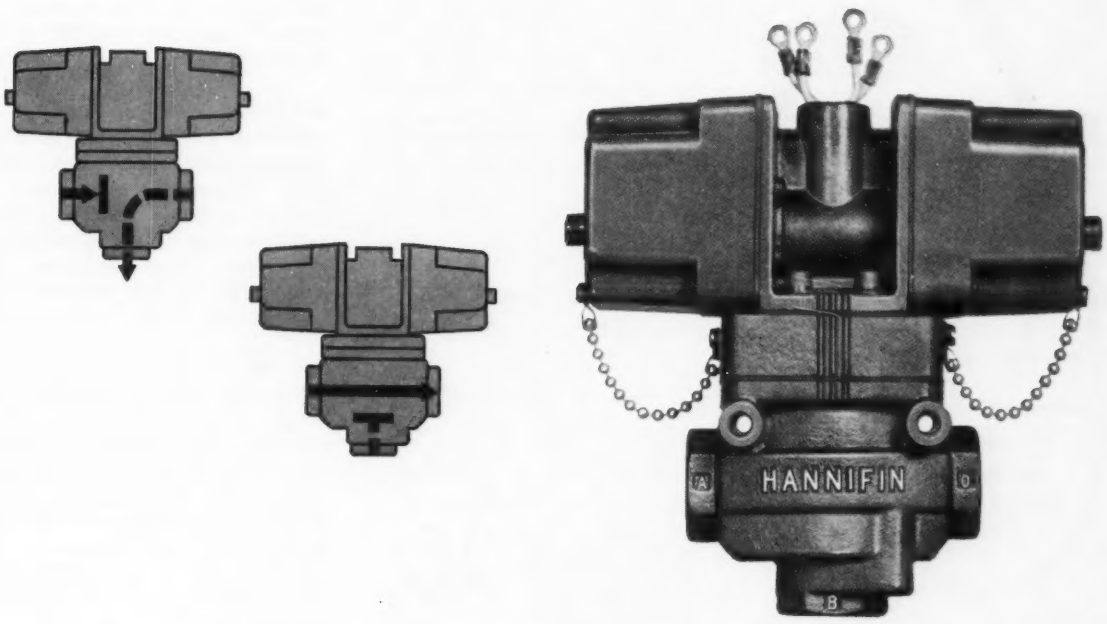
American Society of Mechanical Engineers. Power Conference to be held at the Americus Hotel, Allentown, Pa. Additional information can be obtained from society headquarters, 29 W. 39th St., New York 18, N. Y.

Oct. 23-25—

National Fluid Power Associa-

Setting the pace for automation

...Hannifin valves



Automatic processes call for speed, sensitivity and flexibility in directional air control. Above all, they demand dependability. That is why so many valve users find it pays to choose Hannifin.

Every feature that contributes to dependable performance has been incorporated in Hannifin air control valves. This dependability is the result of never-ending research and development.

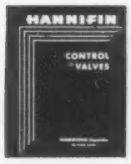
In the broad Hannifin line, you will find valves with new exclusive features... valves for practically any kind of automatic sequential operation. All are simple in design, with few and easily replaceable parts.

AIR CONTROL

HANNIFIN

VALVES

For this complete catalog showing all the Hannifin directional air control valves, write to Hannifin Corporation, 515 South Wolf Road, Des Plaines, Illinois.



Circle 428 on page 19

Whether you're a production man, plant engineer, designer of original equipment, or a manufacturer looking for ways to reduce costs and overhead—there's a way that real savings can be built into machinery used in your industry!

Reduced down-time and repair bills . . . longer machine life . . . increased production . . . elimination of costly hand oiling, and product spoilage due to over-lubrication are only a few of the benefits derived when a Bijur System becomes your "silent partner." Every bearing gets just the *right* amount of clean oil at the *right* time . . . automatically, while the machine is running.

Learn how inexpensive it is to start saving—the Bijur way. Write today for all the facts! ® 1957

BIJUR
LUBRICATING CORPORATION
Rochelle Park, New Jersey
Pioneers in Automatic Lubrication

Circle 429 on page 19

tion. Fall Meeting to be held at Hotel Statler, Washington, D. C. Additional information can be obtained from association headquarters, 1618 Orrington Ave., Evanston, Ill.

Oct. 24-25—

Aircraft Electrical Society. 14th Annual Display of Aircraft Electrical Equipment to be held in the Pan Pacific Auditorium, Los Angeles. Additional information is available from Edward Ryerson, Display Director, 380 Entrada Dr., Santa Monica, Calif.

"The amazing part is, he DOES get five-figure accuracy!"

Oct. 27-30—

American Gear Manufacturers Association. Fall Meeting to be held at the Edgewater Beach Hotel, Chicago. Further information is available from AGMA headquarters, 1 Thomas Circle, Washington 5, D. C.

Oct. 28-31—

Society of Industrial Packaging and Materials Handling Engineers. National Packaging and Handling Exposition to be held at Convention Hall, Atlantic City, N. J. Further information is available from society headquarters, Suite 759, 1 Gateway Center, Pittsburgh 22, Pa.

Oct. 28-31—

American Nuclear Society. Second Winter Meeting to be held concurrently with the Fourth Annual Meeting of the Atomic Industrial Forum and the Third Trade Fair of the Atomic Industry at the Coliseum, New York. Additional information can be obtained from Mr. John Burt, J. M. Mathes Inc., 260 Madison Ave., New York 16, N. Y.

Oct. 30—

Aircraft Electrical Society. First Annual Display of Aircraft Electrical Equipment to be held at U. S. Grant Hotel, San Diego, Calif. Additional information can be obtained from Tom Harrower, Exhibit Director, 5457 Bradna Dr., Los Angeles, Calif.

Nov. 2-8—

National Metal Exposition and Congress to be held at the International Amphitheater, Chicago. The American Society for Metals; the Institute of Metals Div. of the American Institute of Mining, Metallurgical and Petroleum Engineers; and the Society for Non-Destructive Testing will hold technical sessions.

Second World Metallurgical Congress will be held in conjunction with the Metal Show. Information on both meetings can be obtained from ASM headquarters, 7301 Euclid Ave., Cleveland 3, Ohio.

Nov. 4-6—

American Institute of Electrical Engineers. Machine Tool Conference to be held at the Hotel Schroeder, Milwaukee. Additional information can be obtained from AIEE headquarters, 33 W. 39th St., New York 18, N. Y.

Nov. 4-6—

Society of Automotive Engineers Inc. Transportation Meeting to be held at Hotel Statler, Cleveland. Additional information is available from society headquarters, 485 Lexington Ave., New York 17, N. Y.

Nov. 5-6—

Society of Automotive Engineers

(Advertisement)

Design data on adhesives

Armstrong
ADHESIVES • COATINGS • SEALERS

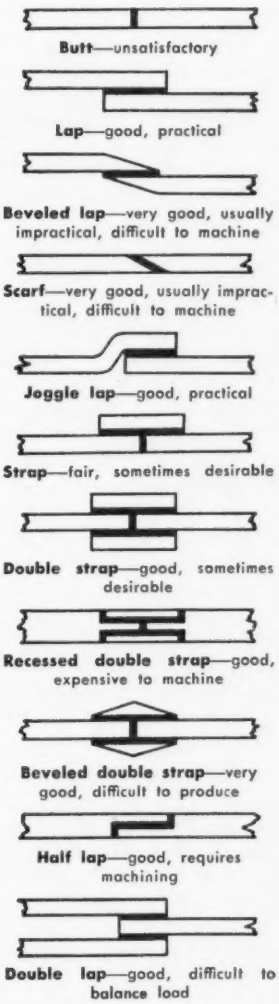
NUMBER FOUR

How to strengthen metal-to-metal joints for flat plates

In order to strengthen any joint to be adhesive-bonded, four basic rules must be kept in mind. These rules are:

1. Make the bonded area as large as possible.
2. Make the maximum proportion of bonded area contribute to strength.
3. Stress the adhesive in the direction of its maximum strength.
4. Minimize stress in the direction in which adhesive is weakest.

Shown below is a variety of flat plate, metal-to-metal joints to which these rules have been applied.



Butt—unsatisfactory

Lap—good, practical

Beveled lap—very good, usually impractical, difficult to machine

Scarf—very good, usually impractical, difficult to machine

Joggle lap—good, practical

Strap—fair, sometimes desirable

Double strap—good, sometimes desirable

Recessed double strap—good, expensive to machine

Beveled double strap—very good, difficult to produce

Half lap—good, requires machining

Double lap—good, difficult to balance load

Adhesive bonding: application of pressure

Effective adhesive bonding always requires some pressure. This pressure may be applied to an assembly in any one of several ways, depending on the nature of the adhesive, design of the part, and its size. Hydraulic presses, hydraulic pads, hydraulic cylinders, air cylinders, spring-loaded jigs, air-filled rubber bags and vacuum bags have all been used satisfactorily.

Whatever the method, though, it must meet these three basic requirements: (1) the amount of pressure should be adequate; (2) pressure should be retained at a constant level; and (3) it should be distributed uniformly over the work.

How much pressure?

The amount of pressure required varies with the kind of adhesive and assembly. Some thermosetting adhesives, for example, require relatively high pressure (as high as 200 psi) for times ranging from 15 minutes to several hours. On the other hand, certain thermosetting epoxy-resin adhesives will form a tight bond at room temperatures with only enough pressure to maintain contact. Contact adhesives require high pressures, but only for brief periods. If in doubt about the amount of pressure, check the adhesive manufacturer's recommendations.

KRAFT PAPER HONEYCOMB CORE is being bonded to sheet aluminum. Panel moves between rubber-covered pinch rolls which deliver uniform pressure. This momentary application of pressure is all that's required for some thermoplastic adhesives.

Note: in some sheet metal assemblies, some pressure may be required to straighten warped sheets and bring them into full contact. This pressure should be added to the bonding pressure recommended by the adhesive manufacturer.

For a pressure device to be satisfactory, it must retain pressure at a reasonably constant level during the curing period, because changes take place during curing which can effectively reduce the applied pressure. Most adhesives flow under pressure. As a result, the over-all thickness of the joint may be reduced and the pressure lowered. Pressure must "follow up" such reduction in thickness. Pressure devices which may hold very tightly at room temperatures may loosen and reduce pressure on the joint at elevated temperatures, due to thermal expansion of the parts. Again, some follow-up is required.

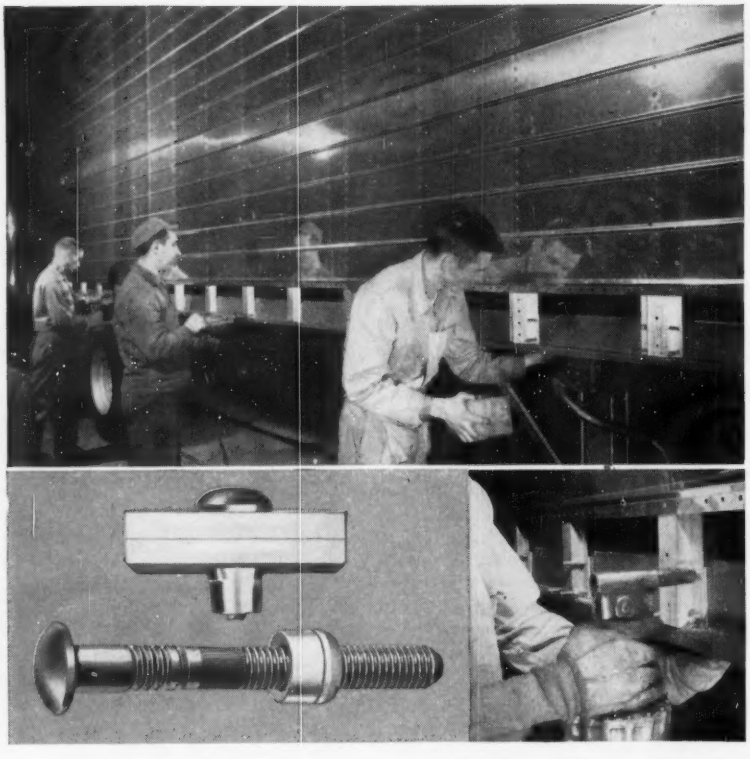
Screw-actuated assemblies like clamps and bolted jigs are not satisfactory when used alone. But if used in conjunction with springs, air-filled rubber pads or any other arrangement that will provide follow-up, screw-type devices will give good results.

Uniform distribution

Uniform distribution of pressure is most important. High and low pressure spots within an assembly can result in lack of uniform contact and differing film thickness—which may result in variability of bond strength. With rigid fixtures or dies, a "pressure pad" like chipboard, rubber-fabric compounds, or glass cloth may have to be interposed between the face of the fixture and the work to equalize pressure. Assemblies bonded in vacuum bags or autoclaves, with the pressure applied directly to the bond and not through fixtures, have excellent pressure distribution.

If you have a design problem involving adhesive bonding, we may be able to suggest a practical, economical solution based on our 36 years of experience in making and using adhesives, coatings, and sealers. Send details of your problem to Armstrong Cork Company, Industrial Div., 8009 Dean St., Lancaster, Pa.

Circle 430 on page 19



Townsend Lockbolts Provide Strong, Vibration-Proof Joints For Rugged Fruehauf Volume ★ Vans

Rugged, high-payload Volume ★ Vans are built using Townsend lockbolts† at critical points to provide the utmost strength. "Fruehauf uses lockbolts because they result in a uniform, high-strength, vibration-proof joint without need of skilled operators," says George Chieger, Executive Engineer.

Townsend lockbolts are easy to apply. The gun engages the pull grooves of the lockbolt. As the trigger is depressed, the work is drawn together with a high clinching action and the collar is swaged into the locking grooves of the pin, forming a permanent lock. The lockbolt pintail then is broken off at the breakneck groove, and ejected from the gun automatically. The entire operation is fast, and requires no special training or skill.

Lockbolts also have advantages in service work, says H. J Biers, Fruehauf General Service Manager, "When field repairs are required that necessitate removal of lockbolts, they always are replaced with comparable lockbolts. If a better fastener were available, Fruehauf would use it."

For a complete explanation of how Townsend lockbolts can help you to obtain stronger, longer-lasting joints, allow us to send one of our representatives. He can give you a complete demonstration right at your desk. Townsend Company, P. O. Box 237-E, New Brighton, Pa.

†Licensed under Huck patents RE 22,792; 2,114,493; 2,527,307; 2,531,048; 2,531,049 and 2,754,703

THE FASTENING AUTHORITY

Townsend

COMPANY • ESTABLISHED 1816

NEW BRIGHTON, PENNSYLVANIA

Sales Offices in Principal Cities

Cherry Rivet Division • Santa Ana, California

Circle 433 on page 19

News Roundup

Inc. Diesel Engine Meeting to be held at Hotel Statler, Cleveland. Further information is available from society headquarters, 485 Lexington Ave., New York 17, N. Y.

Nov. 6-8—

Society of Automotive Engineers Inc. Fuels and Lubricants Meeting to be held at Hotel Statler, Cleveland. Further information is available from SAE, 485 Lexington Ave., New York 17, N. Y.

Nov. 11-13—

Steel Founders' Society of America. Twelfth Technical and Operating Conference to be held at the Carter Hotel, Cleveland. Further information is available from society headquarters, 606 Terminal Tower, Cleveland 13, Ohio.

Nov. 11-15—

National Electrical Manufacturers Association. Annual Meeting to be held at the Traymore Hotel, Atlantic City, N. J. Additional information is available from NEMA headquarters, 155 E. 44th St., New York 17, N. Y.

Nov. 13-15—

American Standards Association. 39th Annual Meeting and Eighth National Conference on Standards to be held at the St. Francis Hotel, San Francisco. Additional information is available from association headquarters, 70 E. 45th St., New York 17, N. Y.

Nov. 18-21—

Air Conditioning and Refrigeration Institute. Tenth Air Conditioning and Refrigeration Exposition to be held at the International Amphitheatre, Chicago. Additional information can be obtained from R. H. Israel, Virginia Smelting Co., West Norfolk, Va.

Dec. 1-6—

American Society of Mechanical Engineers. Annual Meeting to be held at the Statler and Sheraton McAlpin Hotels, New York. Further information is available from ASME headquarters, 29 W. 39th St., New York 18, N. Y.

ALL-ANGLE OPERATION

is only one General Electric Form G Motor* design feature to help you cut costs

Circle 431 on page 19

*NEMA 48- and 56-frames

Years Ahead

PERFECTED PUMPS
Miami, Fla.

UNMATCHED RELIABILITY

"Our precision-built water pumps for swimming pools and sprinkler systems require motors with the highest dependability. G-E fhp motors provide a reliability unmatched by others. General Electric also gives us good back-up service with its network of Small Motor Service Stations."

VEMCO PRODUCTS, INC.
Detroit, Mich.

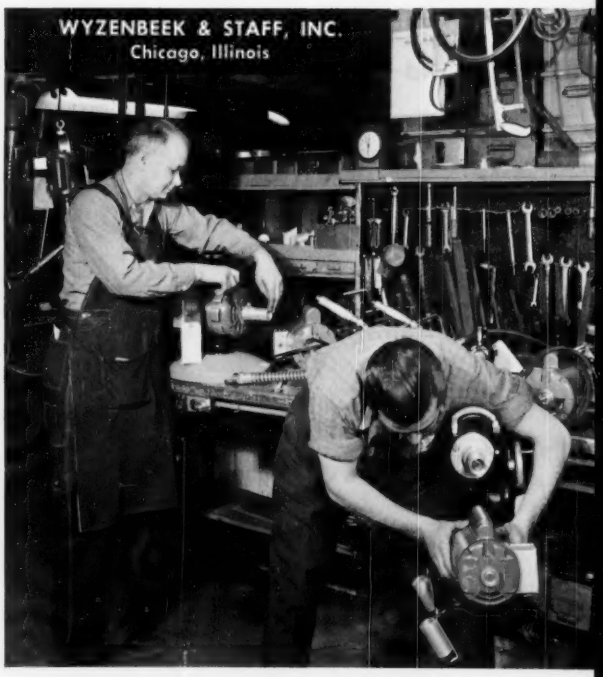
MINIMUM MAINTENANCE

"VEMCO overhead door operators are used on applications ranging from residential garages to commercial car washers and industrial applications, and they're subjected to severe extremes of both temperature and humidity. Even under these conditions, the Form G motor requires no maintenance. It is a very reliable motor."

JENN-AIR PRODUCTS COMPANY, INC.
Indianapolis, Ind.

COMPLETE LINE

"Contractors and architects specify many kinds of power, weather, and safety requirements when our roof and wall exhaust ventilators are installed. We find that the General Electric Company has the broad motor line to meet these various requirements."



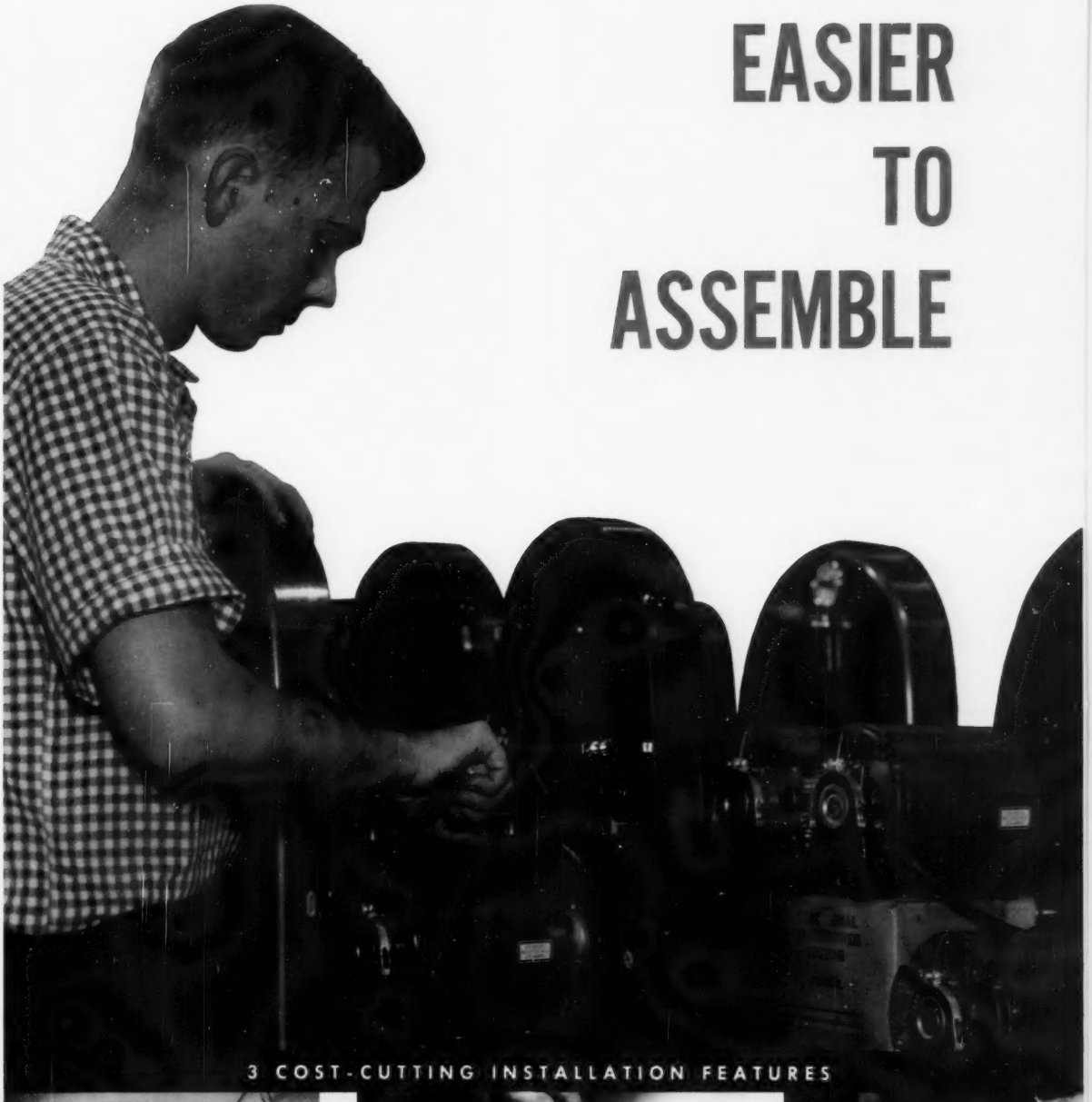
WYZENBEEK & STAFF, INC.
Chicago, Illinois

EXTREMELY RUGGED

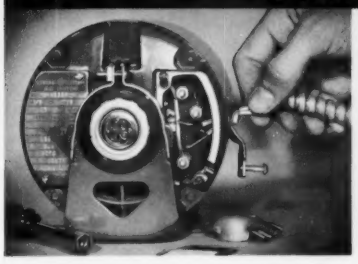
"WYCO Vari-Speed flexible shaft machines take a real beating on the job – we must have a motor that will last. G-E Form G motors withstand exceptionally rough treatment. We also like the helpful information and general assistance that's always available from G.E."

design features make G-E fhp motors

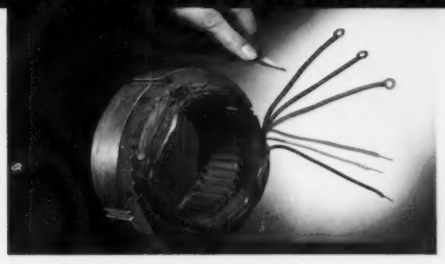
EASIER TO ASSEMBLE



3 COST-CUTTING INSTALLATION FEATURES



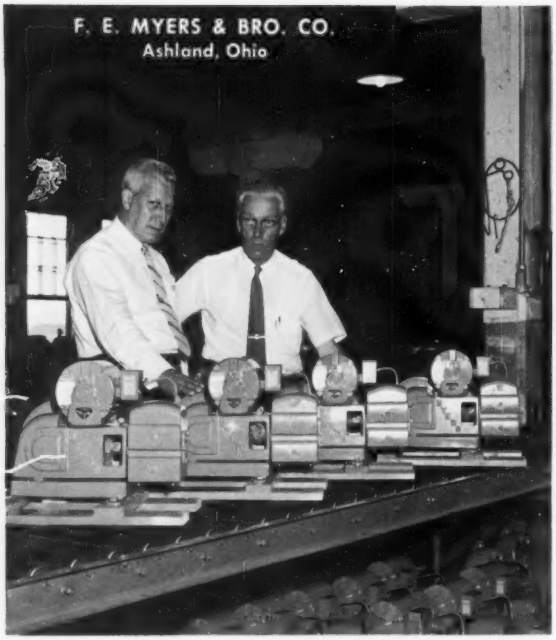
ROOMY TERMINAL BOX permits easy access without sacrificing modern appearance.



PERMANENTLY COLOR-CODED NEOPRENE LEADS mean easy hook-up, happy customers. Assembly is speeded, and maintenance is always easier.

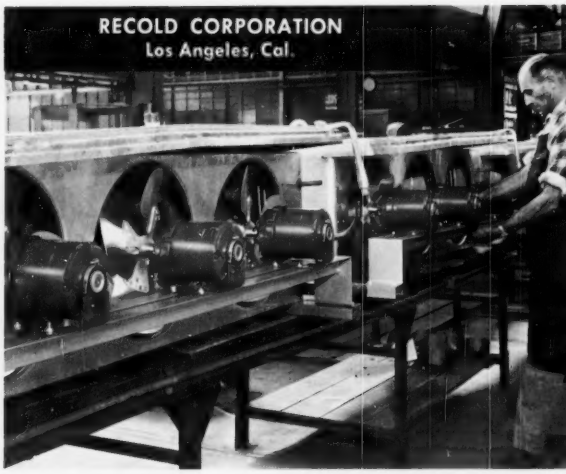
CONDUIT CONNECTIONS are no problem—welded in speed nut simplifies assembly.

- - - General Electric fhp motors can



QUIET OPERATION

"Customers who buy our pumps expect dependable performance, and the G-E Form G motor helps us achieve that. We particularly like the quiet operation of G-E motors. And the Form G motor insulation system of Mylar* polyester film and Formex† wire provides the best protection against moisture we know of."



LONG LIFE — EASY INSTALLATION

"Our refrigerator ventilators are used in large meat storag units, walk-in coolers, and similar equipment, and we us General Electric fhp motors to power the fan. We've foun these General Electric Form G motors are easy to handle quick to install. Moreover, they give our customers the de pendable long life which they require on these installations.

ALL-ANGLE MOUNTING

"When we developed our new S-17E sump pump, we chose the Form G to power it. We saved on initial cost because the General Electric motor offers a new sleeve-bearing design which operates in any position. We required light weight, moisture-proof qualities, and reliable operation. Ninety-day tests showed that G-E motors met each specification."

LIGHT WEIGHT

"When we designed our new oil burner to tak full advantage of G. E.'s light-weight motor, w reduced weight 50% in the finished product. Thi enabled us to go from a wire bound box to a card board carton for additional shipping savings."

an give you these same benefits!

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tions."

MAGNA POWER TOOL CORP.
Menlo Park, California

MORE HP PER POUND

"General Electric's fhp motor provides our redesigned Shopsmith Mark V with 50% more hp, yet it's 5 pounds lighter and ¾ inches smaller in diameter than our former motor. On top of that, its easy-assembly features have helped us increase our Shopsmith production by 30%—without increasing our labor force."

DELTA FAN COMPANY
Jackson, Miss.

LOCAL SERVICE

"Delta 'Sea Breeze' attic fans are sold nationally, and for this reason we require good local service—the best system we know of is the G-E Small Motor Service Station network. Local engineering service from G-E has also been invaluable in selecting the *best* motor for the job."

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G-E FORM G MOTORS WILL GIVE YOU MORE FOR YOUR MOTOR DOLLAR, TOO!

Significant cost savings—greater production—product improvement—extra-services—*these* are the reasons why the ten manufacturers shown here have joined thousands of others in choosing General Electric Form G motors.
You can realize the same benefits by taking advantage of the many advanced-design features proved by the millions of motors already in use.

LONGER MOTOR LIFE means maximum customer satisfaction. In addition to its superior lubrication, the Form G motor is insulated with Mylar* polyester film—which has 35 times the moisture resistance and 8 times the dielectric strength of ordinary paper insulation.

SIMPLIFIED MAINTENANCE results from General Electric's positive lubrication system. An extra-large oil capacity plus a new and highly efficient oil retention system combine to give Form G motors double lubrication life. Oiling is eliminated completely on some applications.

SMALLER SIZE is another cost-saving feature. G-E Form G motors are up to 40% smaller and 50% lighter than previous motor designs—which means easier handling, lower shipping costs.

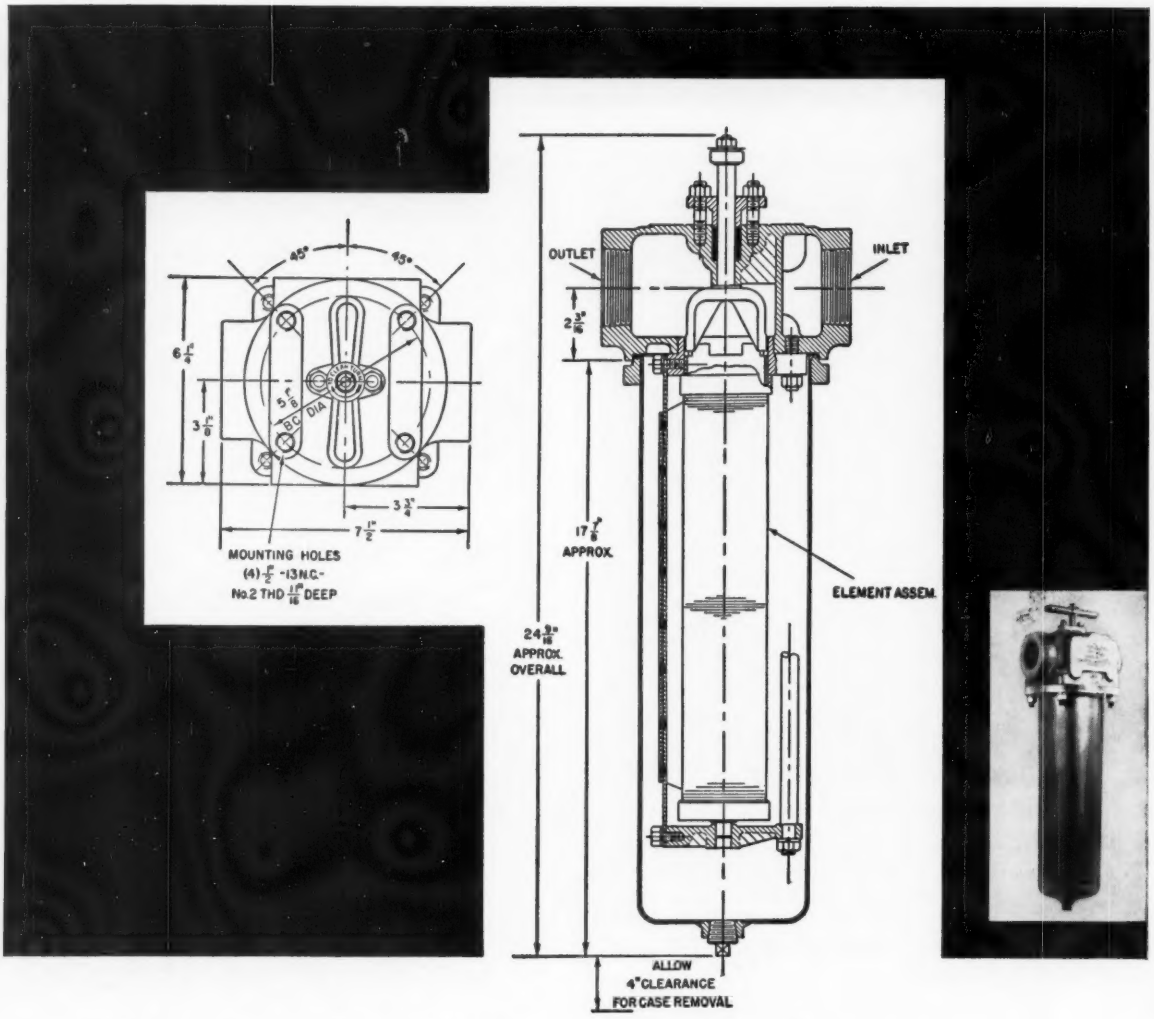
COMPLETE LINE of these advanced-design motors simplifies selection. There's a General Electric Form G motor for practically any fhp motor application you have.

FAST DELIVERY, keyed to your own production requirements, provides you with the motors you want—when you want them! Your nearby G-E Apparatus Sales Office will be glad to help you select the proper motor for *your* products. Contact them for details. Also, write for your copy of Bulletin GEA-6424 to Section 702-60, General Electric Company, Schenectady 5, N. Y.

*Reg. Trade-mark of Du Pont Co.
†Reg. Trade-mark of General Electric Co.

Progress Is Our Most Important Product

GENERAL ELECTRIC



Your "special" filtration problems can be solved by standard Purolator filters

FOR EXAMPLE... This one standard Purolator filter is exactly right for all these "special" filtration problems:

inks, paints,
varnishes, machine tool coolants,
greases, vitamin solutions,
as well as fuel and lube oils.

This filter's specifications may recommend it for a problem of yours. If not, you're almost certain to find a standard Purolator filter that does meet your needs—exactly.

SPECIFICATIONS... This is Purolator filter model G-141J with simplex full flow metal element oil strainers. It is designed for primary or first stage filtration and can be installed on pressure or suction side of pump. Recommended for maximum capacities of 40 to 80 GPM, dependent on spacing which varies from .003 to .010. Relief valves set from 10-12 to 50 PSI are incorporated in several models. Motor driven knife blade to clean element can be furnished whenever conditions make manual rotation impractical. Head is made of high tensile cast iron, body of drawn steel. Inlet and outlet connections are 2″, drain plugs are provided. Maximum pressure: 125 PSI; weight: 37 lbs.

Remember, if these specifications don't match your needs, there's probably a filter that does at Purolator. Find out. Send in your problem.

Filtration For Every Known Fluid

PUROLATOR

PRODUCTS, INC.

Rahway, New Jersey and Toronto, Ontario, Canada

Circle 432 on page 19

Eastman

First to be specified by America's leading OEM's

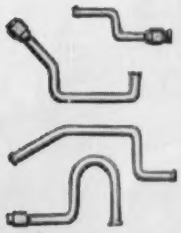
It's a known fact that many leading Original Equipment Manufacturers submit their original specifications for their *first* quotation to Eastman.

EASTMAN's unequalled experience in hydraulic conversion, plus many original designs shown in a few popular Eastman fittings at the right—give your product an appearance of quality that improves its competitive position in your field. It's a mark of distinction to be Eastman equipped!

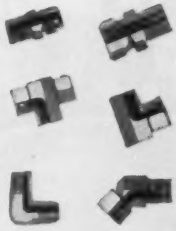
EASTMAN Engineering Service . . . Backed by Unequalled Experience

It is also a known fact that Eastman's co-operative engineering counsel and service is highly respected and often requested by leading OEM's. Let Eastman engineers help you lay out your fluid power lines—from pump to point of work—effecting economies in design, improving performance and increasing user satisfaction.

Let EASTMAN recommend the *best assembly . . . for the best performance . . . at the lowest cost.*



Bent Tubing with the necessary fittings to meet your own specific requirements.



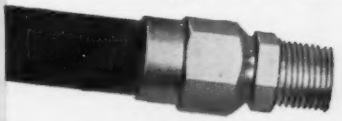
Adapters, Adapter Unions and Boss "O" Ring Fittings. All types and sizes available.

A COMPLETE LINE OF HYDRAULIC FITTINGS and HOSE ASSEMBLIES . . .

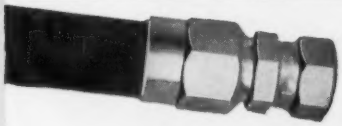
Permanently Attached Male (NPTF) for 1, 2 and 3 wire braid rubber cover hose, and 4 spiral wire extra high pressure hose.
Sizes: 3/16" thru 3".
Wkg. pressure: 375—5000 p.s.i.

Permanently Attached Male Flare (JIC) for 1, 2 and 3 wire braid rubber cover hose.
Sizes: 3/16" thru 2".
Wkg. pressure: 375—5000 p.s.i.

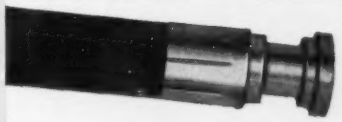
Permanently Attached Swivel Female for 1, 2 and 3 wire braid rubber cover hose.
Sizes: 3/16" thru 2".
Wkg. pressure: 375—5000 p.s.i.



Reusable Male (NPTF) for rubber and cotton cover hose.
Sizes: 3/16" thru 1 13/16".
Wkg. pressure: 375—5000 p.s.i.



Reusable Swivel Female for rubber and cotton cover hose.
Sizes: 3/16" thru 1 13/16".
Wkg. pressure: 375—5000 p.s.i.



Permanently Attached Flanged Head Couplings for 1 and 2 wire braid rubber cover hose.
Sizes: 1/4" thru 2".
Wkg. pressure: 375—5000 p.s.i.

Clamp Type Coupling with split flange stems for 1 and 2 wire braid rubber cover hose.
Sizes: 1/4" thru 2".
Wkg. pressure: 375—5000 p.s.i.

Power Steering Assemblies to meet all your requirements.

Eastman *first in the field*

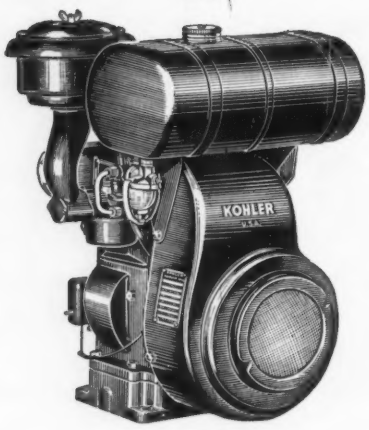
MANUFACTURING COMPANY
Dept. MD-9
MANITOWOC, WISCONSIN

ENGINEERS:
Write for Technical Bulletin 200 for Complete Information and Data on Fluid Power Lines.

Circle 434 on page 19

KOHLER ENGINES

K90



K160

4-cycle · short stroke · air-cooled

—

On-the-job reliability

Kohler engines, in sizes 2 to 24 horsepower, conservatively rated, provide power for a wide range of applications. They are engineered for heavy duty, staunch service, and easy starting. Short-stroke design in each model and size insures smoothness and durability.

The Kohler name is your assurance of quality. Kohler engines power Kohler electric plants, known for reliability the world over for thirty-seven years.

Write for catalog with information about the Kohler engine and its many uses.

K330

K660

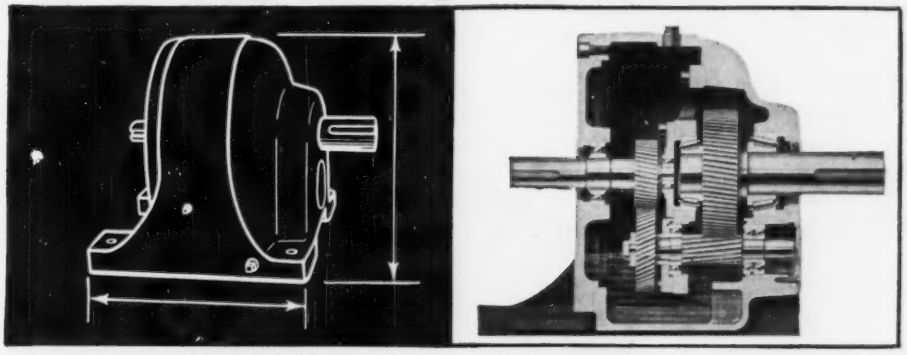
KOHLER CO. Established 1873 **KOHLER, WIS.**

KOHLER OF KOHLER

PLUMBING FIXTURES · HEATING EQUIPMENT · ELECTRIC PLANTS · AIR-COOLED ENGINES · PRECISION CONTROLS

Circle 435 on page 19

NEW compactness outside...
NEW simplicity inside...



MINIMIZED SPACE REQUIREMENTS and easier layouts result from location of input and output shafts in same horizontal and vertical planes.

ONE LOW-SPEED GEAR SET per drive size and maximum accessibility of all operating parts simplify servicing and ratio changes.

... and built for smoother speed reduction *all the way around*

NOW! *LINK-BELT In-Line Helical Gear Drives* immediately available from stocks near you

With these new in-line helical gear drives, Link-Belt offers you a high degree of simplicity and standardization never before achieved in speed reducers. In terms of your production efficiency, it means less and simpler servicing . . . maximum life . . . quick, convenient ratio changes.

Link-Belt also makes an outstanding line of heavy-duty parallel shaft gear drives that cover a wider ratio range up to 300 to 1 and horsepowers to 2000.

Get full information on Link-Belt In-Line Helical Gear Drives from Book 2651 . . . on parallel shaft drives from Book 2619. Ask your nearest Link-Belt office.

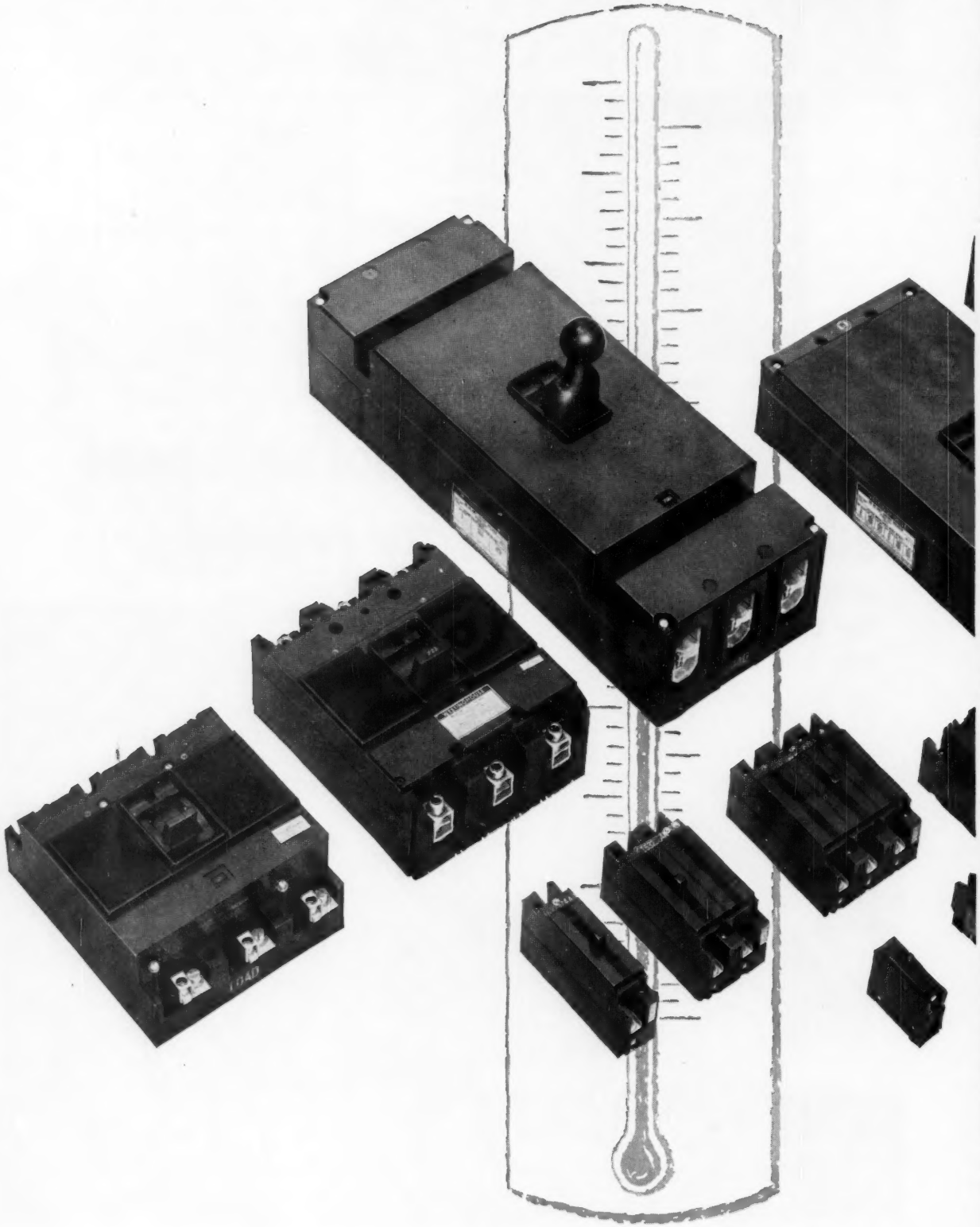
Available with double or triple gear reductions . . . ratios 6.2:1 to 292:1 . . . capacities to 118 hp. Conform dimensionally with new NEMA motor sizes.

LINK-BELT

ENCLOSED DRIVES

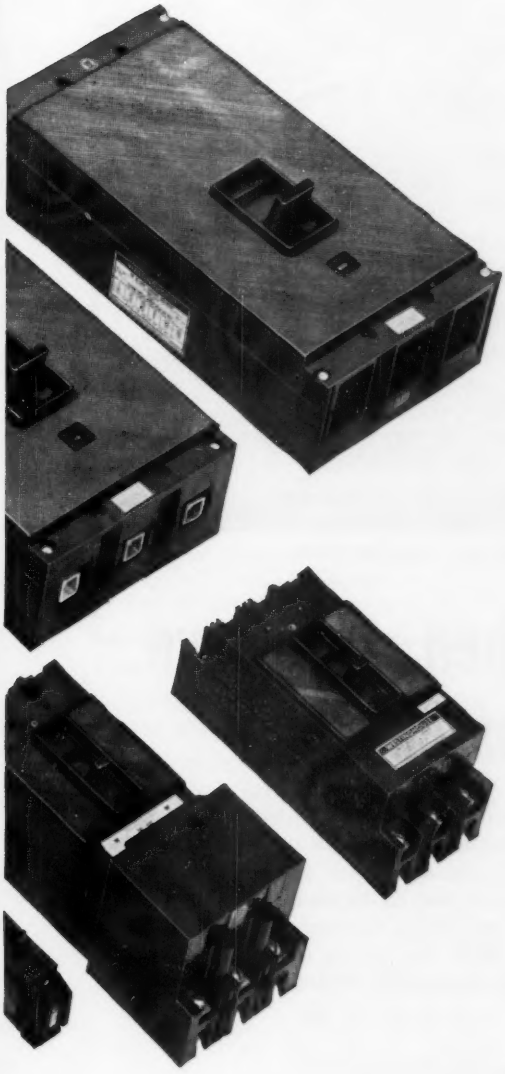
LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World. 14,319-A

The only complete line of



ambient compensated breakers...

Westinghouse



Whenever circuit breakers are subject to wide ambient temperature variations to which associated conductors are not exposed, an ambient compensated type of breaker should be specified. This provides added insurance against current interruptions due to false high-temperature influences. The net effect is to prevent the breaker from unnecessarily derating the conductors.

Typical of the conditions under which ambient compensation may be required are . . .

In panelboards or load centers where a large number of closely grouped breakers create high temperatures.

Proximity of breaker installation to other equipment causing ambient variations to which the conductors are not exposed.

Westinghouse has the only complete line of circuit breakers to meet every requirement. (1) "Compensated for enclosure ambient," standard in Quicklag® breakers, (2) "Noncompensated for ambient re-rating," standard in Types E through M, (3) "Ambient compensated," by specification in Types E through M.

The engineering "know-how" which goes into the development of this reliable protective equipment is available to aid you in selection of the right type of breaker for your particular circuit conditions. Ask for Westinghouse Bulletin 7221 detailing technical information on the choice of circuit breakers.

J-30277

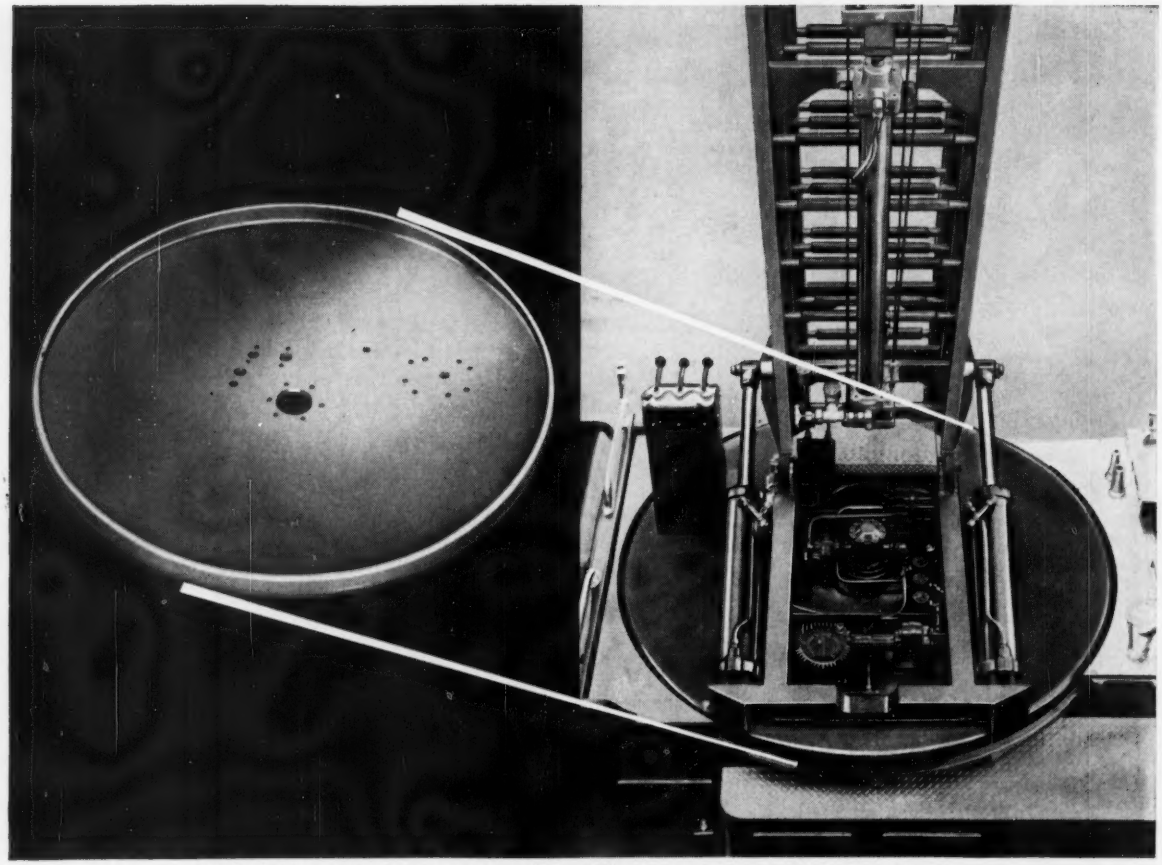
Get proper breaker protection under all ambient conditions.

YOU CAN BE **SURE**...IF IT'S

Westinghouse

Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pennsylvania

Circle 437 on page 19



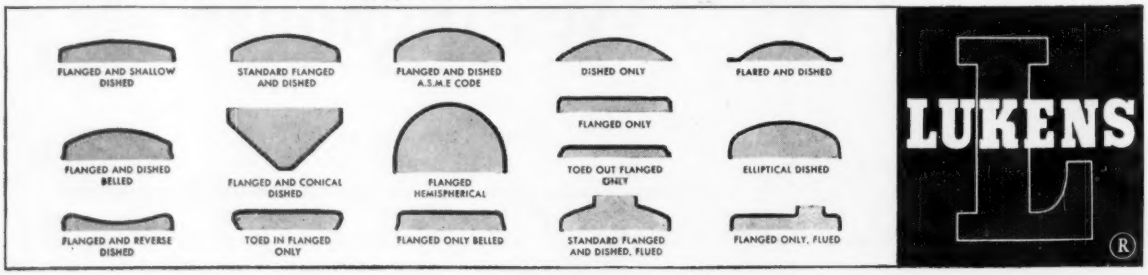
Aerial ladder builder finds notable benefits in designing turntables with Lukens steel heads.

You too can simplify, strengthen...and save... designing with Lukens heads

■ Imagination really paid off for Maxim Motor Company of Middleboro, Mass., producers of aerial ladders for fire-fighting equipment. Using a tough, one-piece Lukens standard flanged head as the ladder turntable, Maxim eliminated fabricating steps and materially lowered costs. The hydraulic mechanism was easily top-mounted for accessibility and ready maintenance.

If you build heavy or light machinery, valves, wheels —even fire engines—imaginative use of Lukens heads may improve your equipment and save you money. Lukens' fifty-five years as the leading producer of spun and pressed steel heads for many applications are at your service. Write for Catalog 937, *"Pricing and Engineering Data."* Lukens Steel Company, Coatesville, Pa.

Lukens Offers the World's Broadest Line of Spun and Pressed Heads of Carbon, Alloy and Clad Steels

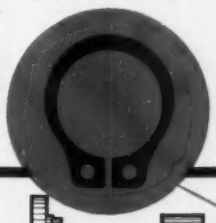


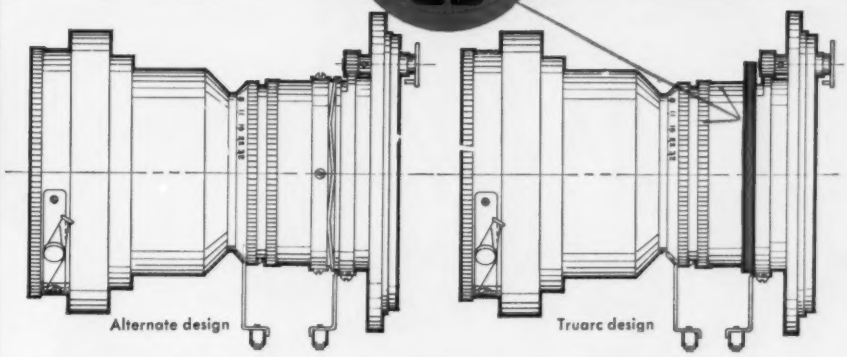
Circle 438 on page 19

Waldes Truarc Retaining Ring eliminates 7 parts, saves $8.88 in sub-assembly of aerial reconnaissance camera

Gordon Enterprises, No. Hollywood, California, saved the Navy almost 1½ million dollars on 500 cameras. Gordon rebuilt new, efficient "CA" series out of Navy-owned obsolete models. Critical parts are now held together by Waldes Truarc Retaining Rings.

Truarc Rings are trouble-free, will not change position during operation. Accuracy is limited only by groove and ring dimension tolerances. And standardized Truarc Rings are quickly interchangeable in overhaul which now takes only 11 minutes, can be handled by unskilled technicians.





Truarc 5100-287 ring retains shutter speed adjustment mechanism on the Lens Adapter Plate Assembly which mounts and locks the lens and shutter assemblies accurately to camera body. Alternate design required retaining washer, spring, collar and 4 locking screws.

Weight Saving: 7.25 oz.

Assembly Time Saving: . . . . . 6½ min.

DOLLAR SAVINGS:

Material	**$ .93**
Fabrication	**6.88**
Inspection	**1.07**
Total	**$8.88**

Whatever you make, there's a Waldes Truarc Ring designed to save you material, machining and labor costs, and to improve the functioning of your product.

In Truarc, you get

Complete Selection: 36 functionally different types. As many as 97 standard sizes within a ring type. 5 metal specifications and 14 different finishes. All types available quickly from leading OEM distributors in 90 stocking points throughout the U. S. and Canada.

Controlled Quality from engineering and raw materials through to the finished product. Every step in manufacture watched and checked in Waldes' own modern plant.

Field Engineering Service: More than 30 engineering-minded factory representatives and 700 field men are at your call.

Design and Engineering Service not only helps you select the proper type of ring for your purpose, but also helps you use it most efficiently. Send us your blueprints today...let our Truarc engineers help you solve design, assembly and production problems...without obligation.

For precision internal grooving and undercutting . . . Waldes Truarc Grooving Tool!

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TRUARC®

RETAINING RINGS

WALDES KOHINOOR, INC.

47-16 AUSTEL PLACE, L. I. C. 1, N. Y.

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.

Please send new, descriptive catalog showing all types of Truarc rings and representative case history applications. *(Please print)*

Name _____

Title _____

Company _____

Business Address _____

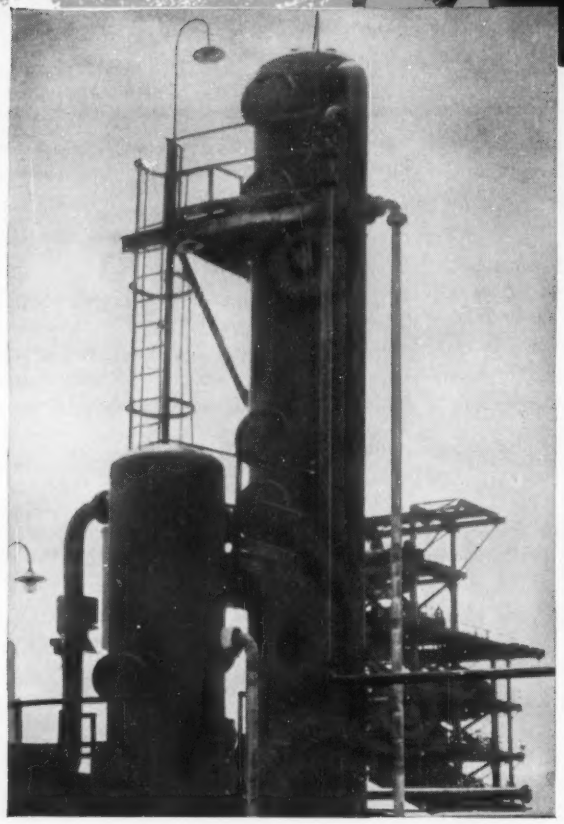
City _____ *Zone* _____ *State* _____

MD 099

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.

HEAT • WEAR • CORROSION

HAYNES Alloys solve the *tough*

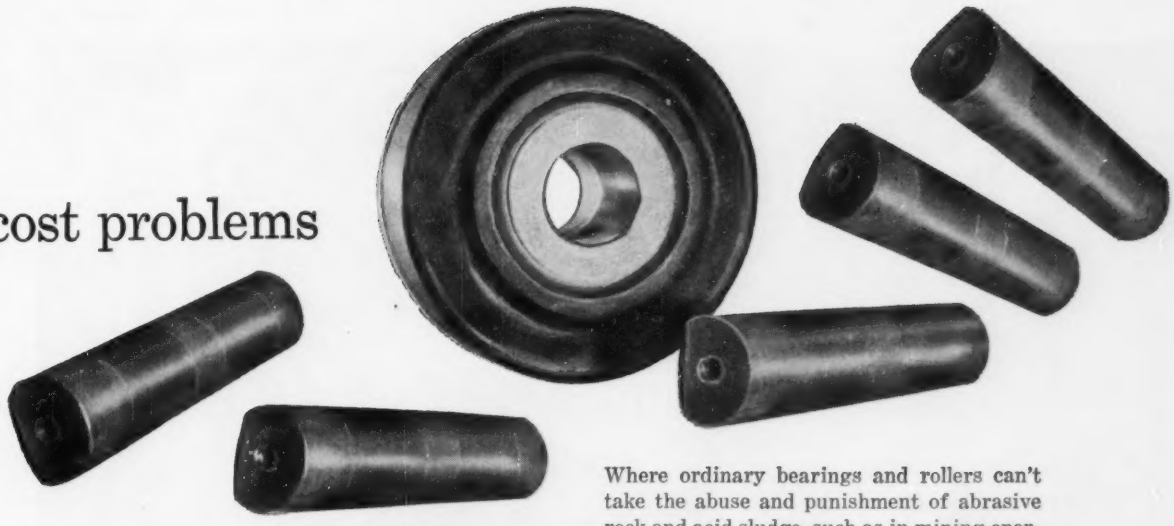


CORROSION

HASTELLOY Alloy B has a service life 30 to 40 times that of ordinary materials while handling highly reactive hydrogen chloride gas at a chemical plant.

In petroleum, chemical, or food processing industries—wherever you find highly corrosive conditions—HAYNES Alloys are long-wearing and most economical.

cost problems

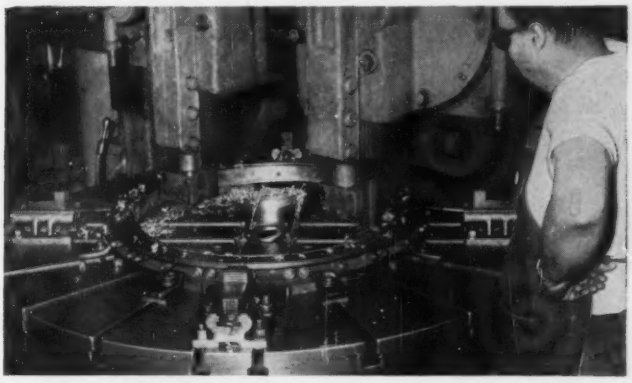


ABRASION

Where ordinary bearings and rollers can't take the abuse and punishment of abrasive rock and acid sludge, such as in mining operations, they are hard-faced with HAYNES STELLITE Alloy No. 6 and last for years instead of weeks! HAYNES Alloys reduce maintenance and replacement costs by giving long service.

Wherever you have a *tough* cost problem due to maintenance or replacement expense caused by excessive wear, heat, or corrosion, or where there is a complex design or production problem—investigate the use of HAYNES Alloys.

In practically every industry, you will find HAYNES Alloys helping to increase production and reduce maintenance—doing an efficient job at low cost. For information on HAYNES Alloys, contact our nearest sales office or write HAYNES STELLITE COMPANY, Division of Union Carbide Corporation, General Offices and Works, Kokomo, Indiana. Sales Offices in Chicago, Cleveland, Detroit, Houston, Los Angeles, New York, and San Francisco.



MACHINING

HAYNES STELLITE 98M2 alloy tools remove metal fast in machining jet engine diaphragm rings. These tools take a ½-in. cut and remove 55 cubic in. of metal in 15 minutes. About six rings now are machined per grind where other tools failed to finish even one. And tool service life has jumped over 600 per cent. Fast, precision machining with long tool life makes a big difference in production costs.

HAYNES
ALLOYS
HAYNES STELLITE COMPANY
Division of Union Carbide Corporation

UNION CARBIDE

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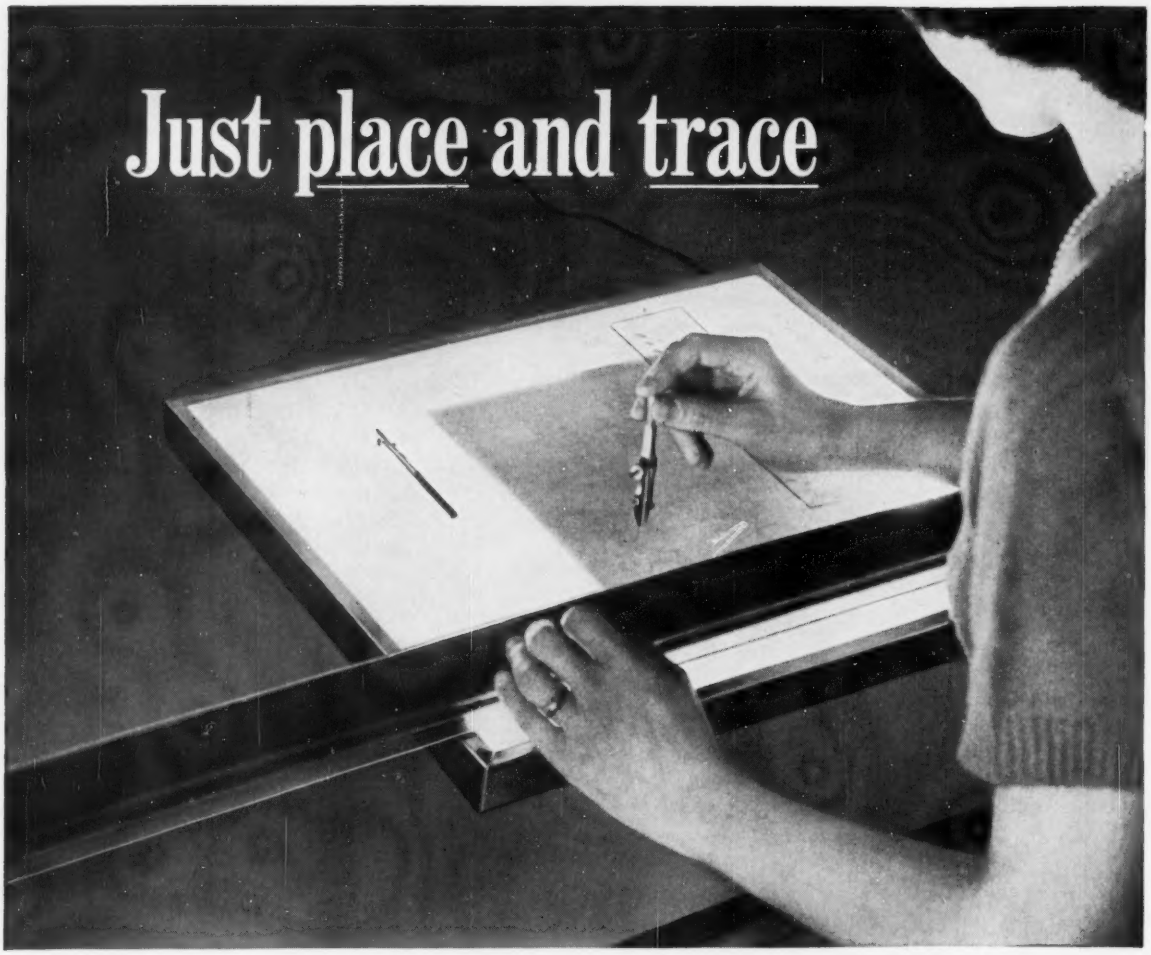


Lightweight, portable tracing unit is only 1 7/16 inches *thin*

Now you can trace *right at the drawing board*, and save precious minutes with PORTA-TRACE®—the thin, lightweight tracing box that *comes to you.*

Simply pick it up . . . place it on your board . . . flick a switch and you're ready —in seconds!

Only 1 7/16 inches deep, PORTA-TRACE can actually be used under the straight edge of your drafting table! Its flush top permits use with drawings larger than unit itself. Strong Plexiglas top is enclosed by rugged, long-life stainless steel frame. Available in four sizes up to 24″ x 36″.

Save drafting time and precious space with PORTA-TRACE. Call your local Ozalid representative or write Ozalid, Dept. GG-9, Johnson City, N. Y.

A Division of General Aniline & Film Corporation
In Canada: Hughes Owens Company, Ltd., Montreal

USING

DU PONT ELASTOMERS

neoprene · Hypalon®

in design

An acid handling problem solved with a liner of HYPALON

Expanding grinding head of neoprene holds abrasives without spindle nuts

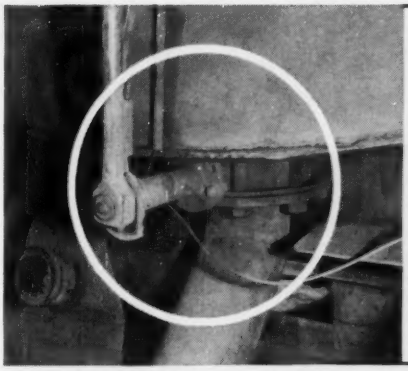
Another new use for Du Pont neoprene is this grinding head made by a midwestern manufacturing company. The head—a slotted neoprene wheel—permits instant changes of the abrasive sleeve merely by slipping it on or off. There are no spindle nuts to tighten, no tools needed. When the motor is started, centrifugal force expands the resilient neoprene against the inner surface of the abrasive element and holds it firmly in place as it grinds.

Downtime for changing abrasives is cut to a minimum. Abrasive life is increased considerably. Smoother performance is assured. And neoprene's resiliency also makes possible higher quality contour work. The expanding wheels are made in sizes from ½-in. to 18-in. diameters.

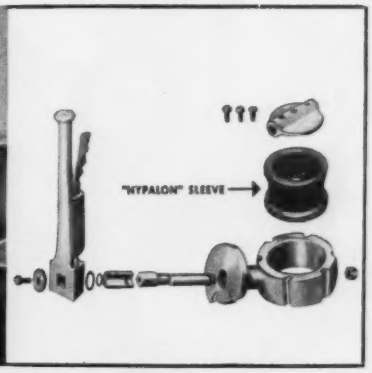
Neoprene's resilience is one of a *balanced combination* of properties which adapt it to a wide variety of industrial applications. Its resistance to sunlight and weather, abrasion, oil, grease and chemicals means long-term wear—and economy in many types of service. Mail coupon for full information on neoprene.

Resilient neoprene grinding head expands under centrifugal force and holds abrasive sleeve in place as it grinds. No nuts or tools are required.

Circle 442 on page 19



Butterfly valve lined with HYPALON has handled spent acids three years without replacement.



Metal damper rotates in ring-piece with a sleeve of HYPALON. Squeezed shut, the sleeve makes a pressure-tight seal. Opened, it returns to its original shape.

6-in. butterfly valves weighing only 30 lbs. replace 250-lb. models

Industrial Wastes, Inc., of Beaver Falls, Pa., hauls and neutralizes spent acids from Pittsburgh steel mills. Each month its tank trucks handle 2½ million gallons of spent acid—mixtures of nitric, sulfuric, hydrochloric and hydrofluoric.

For years Industrial Wastes, Inc., tried various outlet valves, but even the most satisfactory valve had disadvantages. Made of expensive and heavy metals, the valve weighed 250 lbs., which made it cumbersome to install and required special supports to prevent stress fatigue in the tank shell. Too, sediment clogging meant frequent cleaning of the valve through a rodding-out hole. This damaged the neoprene tank lining and reduced its protection against acid corrosion of the shell.

Three years ago the company installed a self-cleaning 30-lb. butterfly valve with a resilient sleeve of HYPALON. In this case, HYPALON not only protects the metal valve body from corrosion, but acts as a resilient valve seat for the butterfly as well as a flange for the gasket. The original lightweight valve—a design that cost 40% less than previous valves—is still in service.

The excellent chemical resistance of HYPALON, Du Pont's *newest* synthetic rubber, made it the logical choice for this design. HYPALON has many properties you'll find useful when your design calls for a resilient material with good resistance to most chemicals, temperatures of 250° F.-350° F., ozone concentrations or other tough operating conditions. For more information on the properties of HYPALON, merely mail the coupon below.

DU PONT

HYPALON *is a registered trademark of E. I. du Pont de Nemours & Co. (Inc.)*

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

☐ I am particularly interested in _____

☐ Send me a free copy of *The Du Pont Elastomers* (a review of properties of neoprene and HYPALON).

☐ Add my name to the free mailing list of the *Elastomers Notebook* (contains articles based on uses of Du Pont elastomers in industry).

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Elastomer Chemicals Dept. MD-9
Wilmington 98, Delaware

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Firm _____

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NEW CONCEPTS . . .

Whitney Chain engineers have recently developed two revolutionary designs . . . Self-Lube Roller Chain and "F-R" Processed Roller Chain. Each completely proven in the field, these chains can open entirely new cost-saving concepts for your drive-design programs.

Whitney Self-Lube Chain outlasts regular chain by as much as 5 to 1 under continuous service in extremes of dust or moisture. Here, Whitney's exclusive sintered steel bushings "oil cleanly from the inside", are prelubricated for life, cannot trap abrasive matter which cuts chain life. Ideal for applications in food, drug, textile and many industries where ordinary chain lubrication results in product damage.

And Whitney's new "F-R" Processed Roller Chain is establishing new service standards for durability, particularly on problem drives involving unusual operational conditions, stresses and heavy shock loads. This performance comes from the exclusive Whitney "F-R" process which offsets excessive operational stresses in the chain.

These new chains with dynamic, balanced design, serve better, longer and at less over-all cost . . . and so does Whitney's entire line of chain . . . developed by specialists with over 60 years' know-how in *your* drive field.

Whitney field engineers, warehouses, and alert distributors assure top service from complete stocks . . . nation-wide. Write for full technical literature.

Whitney

CHAIN COMPANY

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ROLLER CHAIN • SILENT CHAIN • CONVEYOR CHAIN • SPROCKETS • FLEXIBLE COUPLINGS

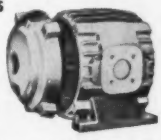
Circle 443 on page 19

rough CONDITIONS?

TYPE J
1 TO 30 H. P.
Rerated Frames
182 to 326U

U.S. TOTALLY-ENCLOSED MOTORS

Protected **AGAINST CORROSION ALL EXPOSED PARTS CAST IRON...**



Rust-resistant solid cast iron withstands abuse, wear and corrosion. *Protects* working parts!

Protected **BY LUBRIFLUSH FOR LONGER BEARING LIFE**

New grease forces old grease out—keeps bearings fully lubricated. *Protects* bearing efficiency!

Protected **AGAINST INTERNAL HEAT WITH ASBESTOS WINDINGS**

Nature's greatest heat resistor, asbestos can't carbonize! *Protects* windings against heat!

Protected **FROM STRESS AND WARP BY NORMALIZING CASTINGS...**

All cast-iron components are heat-seasoned to stabilize molecular structure. *Protected* against warp!

Total Protection in every direction

Large savings are being gained by many industries using *enclosed* motors in place of the usual "open" or ordinary protected motor. U.S. Totally Enclosed gives *total* protection in every direction—from corrosion, dusts, abrasives, impact, weather, spray and splash! This means motor dependability ...long life...savings both on motor costs and production continuity!

MAIL COUPON NOW ▼

U.S. *Electrical* MOTORS

Circle 444 on page 19

U.S. ELECTRICAL MOTORS, Inc.
Los Angeles 54, Calif.—Box 2058, Milford, Conn. MD-9

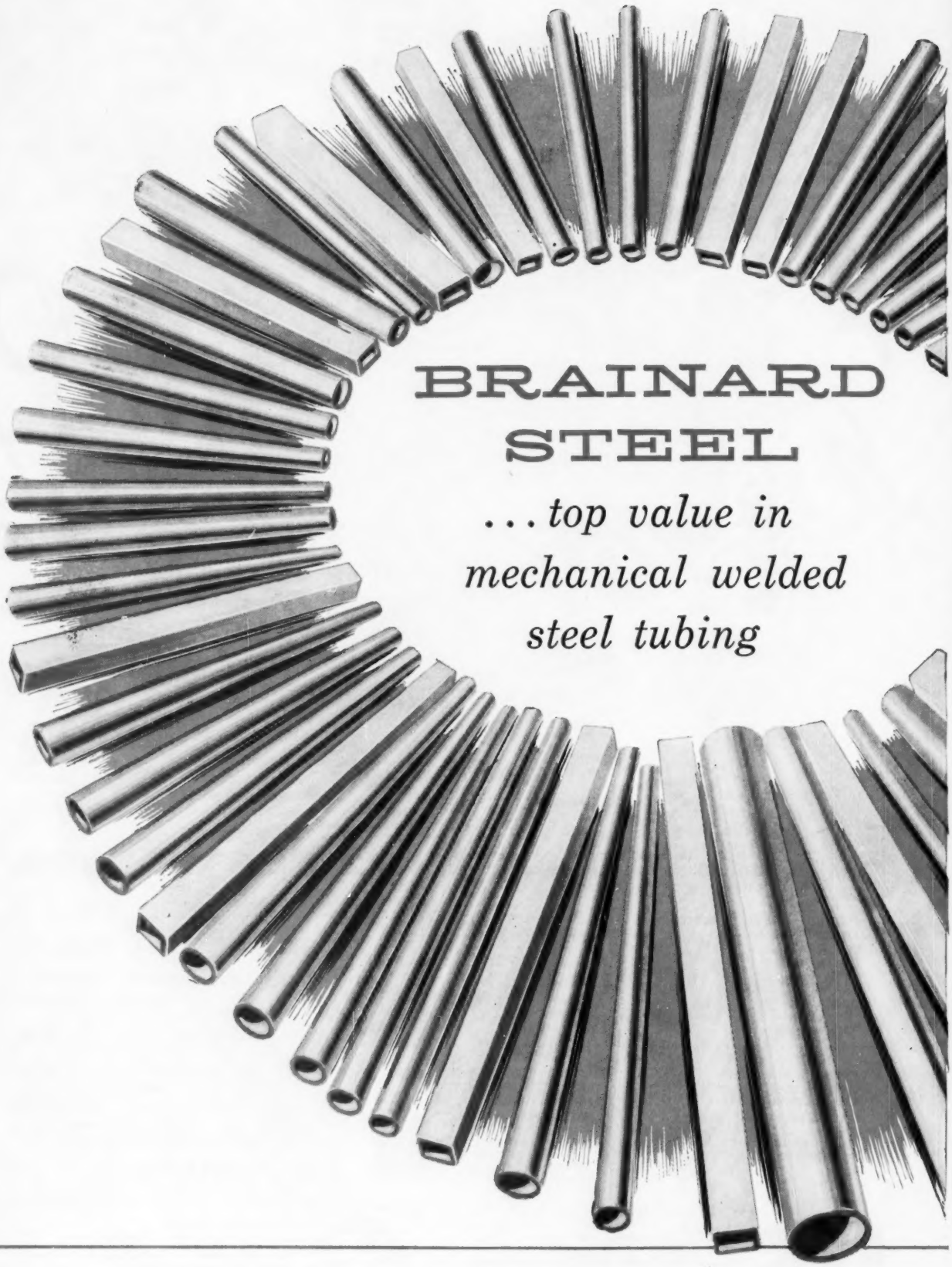
Gentlemen: Please send me complete information in your Totally-Enclosed Motors.

NAME _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE ____ STATE _____


BRAINARD
STEEL
...top value in
mechanical welded
steel tubing

BRAINARD mechanical welded steel tubing is a top value buy because they give assured quality at competitive prices. Brainard Tubing, in sizes from ½" to 4" is also available in squares, rectangles, and special shapes.

VALUE = QUALITY / PRICE = BEST BUY!

Buying from Brainard has hidden values too!

DELIVERY! As a division of Sharon Steel, Brainard is assured of a constant supply of all grades of steel and can meet your delivery schedules.

VERSATILITY! Available in special shapes. Brainard Electric Welded Steel Tubing can also be swedged, pressure tested and delivered in many fabricated forms.

SERVICE! With a growing field organization, Brainard has representatives in all major cities and that's not all — Brainard will quote your requirements in short order.

so buy Brainard

SEND FOR THIS BOOKLET
For complete information on Brainard's Mechanical Welded Tubing.

BRAINARD STEEL TUBING
Griswold St., Warren, Ohio

Name _____

Address _____

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Brainard Steel Tubing

401

SHARONSTEEL

Brainard Steel Division, Sharon Steel Corporation
Griswold Street, Warren, Ohio

Circle 445 on page 19

how's this for *performance?*

15 lbs. of scrap after cutting 156 parts from a 6′ x 10′ plate of ⅜″ steel

Using four torches guided by an electronic tracer, an Airco #48 Duograph automatically flame cut 156 parts from a ⅜″ x 72″ x 120″ steel plate. Of the original 918 pounds of sheet steel, only 15 pounds of scrap remained. Discover the advantages to be gained by using Airco flame-cutting machines for fast, economical production. In addition to the #48 Duograph, Airco flame-cutting machines include the Airco Travograph, Oxygraph, Duograph, Monograph, Camograph, and Radiagraph. Write Airco for complete information and literature.

AT THE FRONTIERS OF welding PROGRESS YOU'LL FIND . . .

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Products of the divisions of Air Reduction Company, Incorporated, include: **AIRCO** — industrial gases, welding and cutting equipment, and acetylenic chemicals • **PURECO** — carbon dioxide — gaseous, liquid, solid ("DRY-ICE") • **OHIO** — medical gases and hospital equipment • **NATIONAL CARBIDE** — pipeline acetylene and calcium carbide • **COLTON** — polyvinyl acetate, alcohols, and other synthetic resins.

For fast, cold sandwich bonding ...3M Adhesive EC-1357

NIP ROLLER OR COLD PRESS COMPLETES STRONG, LIGHTWEIGHT SANDWICH PANELS WITH EC-1357. YOU NEED NO HEATED PRESSES.

Gain the speed and economy of cold bonding! Fabricate sandwich panels for non-load bearing uses with 3M Adhesive EC-1357.

This high-strength, flexible adhesive bonds sandwich panels without clamps or heated presses. You force-dry the solvent out of the adhesive before bonding. Cold press or nip roller finishes the job. You get maximum immediate strength. And EC-1357 builds up even more strength with age as it cures at room temperatures.

Because it is dark in color, EC-1357 absorbs drying heat fast. Thus it cuts production time, allows continuous movement from adhesive spraying to finished panel. EC-1357 resists moisture and normal temperatures, too. For load-bearing panels, investigate 3M Adhesive EC-1177.

SEE WHAT 3M ADHESIVES CAN DO FOR YOU!

Consult 3M research. Contact your 3M Field Engineer. Or for information and free literature, write on your company letterhead to:3M,Dept. 109, 417 Piquette Ave., Detroit 2, Mich.

PRODUCT OF 3M COMPANY RESEARCH

MINNESOTA MINING AND MANUFACTURING COMPANY · ADHESIVES AND COATINGS DIVISION

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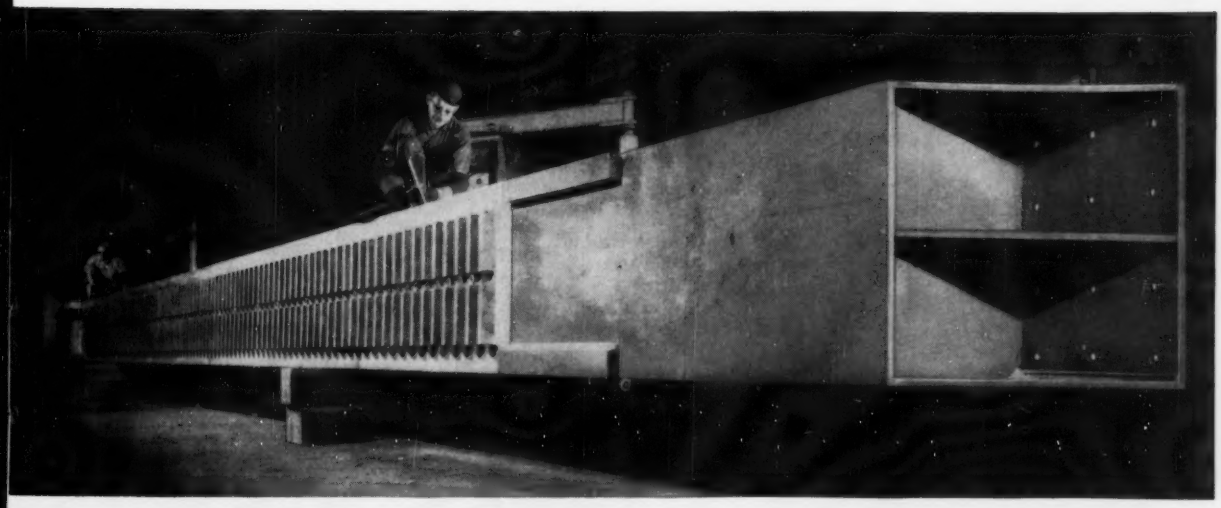
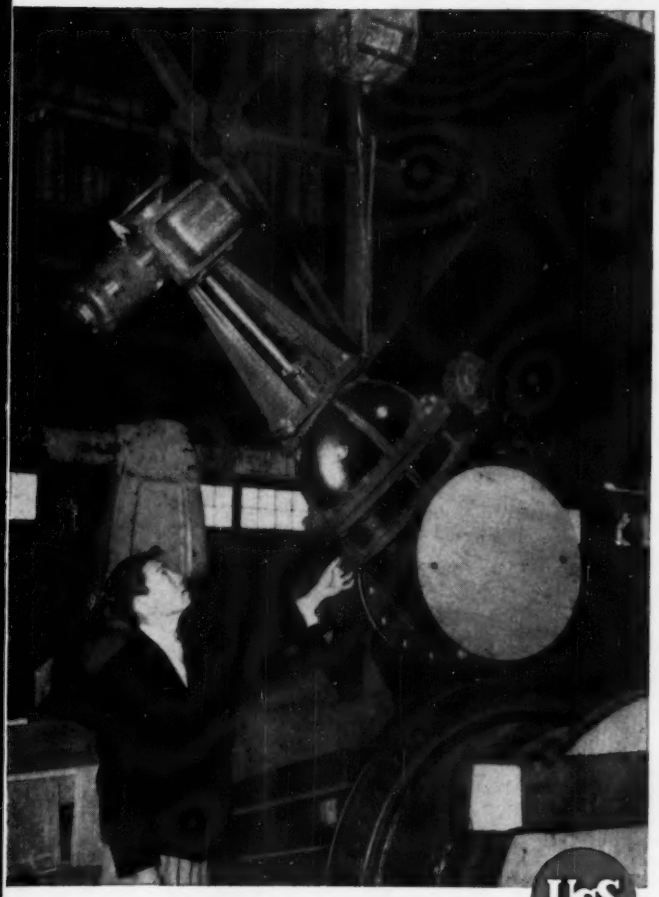
Circle 447 on page 19

HOW USS "T-1" STEEL IMPROVES THESE PRODUCTS:

First Major Bridge Application for "T-1" Constructional Alloy Steel—USS "T-1" Steel is being used in the construction of the $20-million Carquinez Straits Bridge, which will connect the busy San Francisco Bay area with the Sacramento Valley. Almost a duplicate of the 30-year-old existing structure it parallels, the new bridge, at left, differs most in that it is making use of 2,900 tons of USS "T-1" Steel. And those are 2,900 important tons because, according to design computations by the State of California, USS "T-1" Steel's weldability and 90,000 psi minimum yield strength will *lower* the cost of the bridge some $800,000. For example: one of the top chord members of the new bridge will weigh 400 lbs. per ft. and have a section area of 117.19 sq. in. A structural carbon steel (A-7) member for the same location would weigh 996 lbs. per ft. and would require a section of 293 sq. in.





At Home In A Crowd. That's USS "T-1" Steel. It's really at home in this, the crowd rack of the world's largest power shovel. Built by Marion Power Shovel Company, the big digger is in service for Hanna Coal Company. Operating around the clock, winter included, the crowd rack must withstand constant, brutal impact loading, often in sub-freezing temperatures. USS "T-1" Steel (also used in the dipper, dipper stick and bail) supplies the strength, toughness, and resistance to impact abuse so critically needed.

Fabri-Valve Fabricates Faster For Less. The Fabri-Valve Company of America fabricates valves as opposed to casting them. A recent job for the U.S. Air Force called for 2 types of electric-motor-operated wedge-gate valves, subject to temperatures from well below zero up to 300° F., and pressures of 37.5 psi absolute plus a shock load of 200 psig. By using USS "T-1" Steel for the majority of the valve parts, Fabri-Valve pared off 25% of the time and expense normally required to fabricate the valves. Quoting the Company's Vice President, "USS 'T-1' Steel was chosen for its toughness, impact strength, its quality of handling low temperature applications. Very important, too, is its ready weldability and fabricability. USS 'T-1' Steel's yield strength of 90,000 psi helped reduce thickness, thereby reducing cost."

HOW IT CAN HELP YOU

USS "T-1" Steel, with its high minimum yield strength of 90,000 psi and its minimum tensile strength of 105,000 psi, can help you design or build lighter-weight equipment that will last longer. Its unusual toughness can help you design or build equipment capable of taking severe impact and abuse at sub-zero temperatures. Its weldability can help you cut the cost of fabricating highly stressed parts, and reduce repair and maintenance expense. Its good creep rupture strength can help you put more durability in equipment that operates at temperatures as high as 900 degrees F.

Somewhere in your operation, versatile USS "T-1" Steel can help you. Write, wire, or phone United States Steel, Pittsburgh 30, Pa.

USS "T-1" CONSTRUCTIONAL ALLOY STEEL

"USS" and "T-1" are registered trademarks

United States Steel Corporation, Pittsburgh • Columbia-Geneva Steel Division, San Francisco • Tennessee Coal & Iron Division, Fairfield, Ala.
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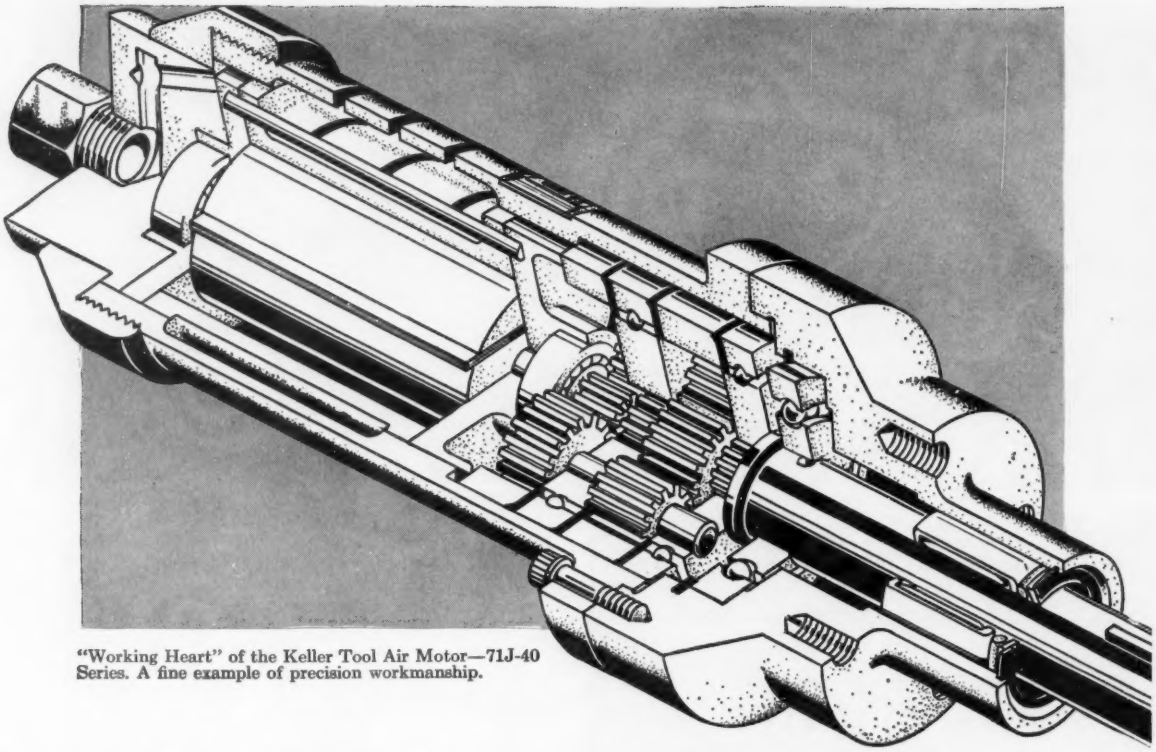
UNITED STATES STEEL

Circle 448 on page 19



"Working Heart" of the Keller Tool Air Motor—71J-40 Series. A fine example of precision workmanship.

Look inside before you decide

Air motors look pretty much alike—from the outside. It's the inside "working heart" that decides how long they give satisfactory service without frequent trips to the repair shop. There's work for a Keller Tool Air Motor in many design applications.

HERE ARE REASONS WHY 71J-40 IS A LEADER

- **Compact . . . Powerful.** One full horsepower in a vane-type air motor less than 13 inches long.
- **Quick starts . . . Quick stops**—unlike an electric motor. Stands up under this type of usage.
- **Non-sparking.** Air power is safe . . . eliminates hazard present when using other types of motors.
- **Will not burn out** . . . because there is nothing to burn out. Can run to a stall without damage.
- **Heavy-duty construction**—to stand up under heavy loads. Heavy cast aluminum gear case and motor housing.

Send for Bulletin 71 for specifications.

Other leaders in the Keller Tool and Gardner-Denver Air Motor Family

Keller Tool Axial Piston Air Motor—70A Series from ½ to 2¾ h.p.—Bulletin 70.

Gardner-Denver Five-Cylinder, Radial Air Motors from 3 to 16 h.p.—Bulletin AM-1.

ENGINEERING FORESIGHT—PROVED ON THE JOB
IN GENERAL INDUSTRY, CONSTRUCTION, PETROLEUM AND MINING

GARDNER-DENVER

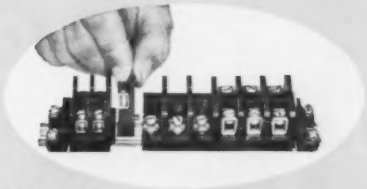
Gardner-Denver Company, Quincy, Illinois

Circle 449 on page 19

50% MORE TERMINALS IN THE SAME SPACE!

SQUARE D's *NEW* TERMINAL BLOCKS

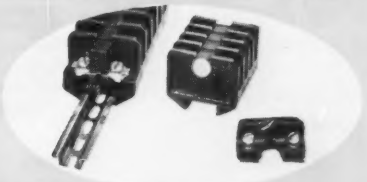
MORE FLEXIBILITY, TOO!



NOTICE *(above)* how little space is required to remove or add a Square D channel-mounted terminal block to the completely assembled unit. Especially important for a quick change when an additional terminal must be inserted into grouping.

LOOK *(at right)*... all sizes can be mounted on same channel...25 ampere pressure wire connectors, 25 to 50 ampere box lugs ...all can be interlocked together. Terminals in kit form to "do-it-yourself" or factory-assembled to standard specifications.

SEE *(below)*...there is only one perforated channel required for either weld or screw-on mounting...available in standard lengths that can be cut "on the job" to fit any length requirement. Eliminates stocking various sizes.



ASK YOUR SQUARE D FIELD ENGINEER
or write for Bulletin which covers details on Channel-Mounted Terminal Blocks. Address Square D Company, 4041 North Richards Street, Milwaukee 12, Wisconsin.

NOW...EC&M PRODUCTS ARE A PART OF THE SQUARE D LINE

SQUARE D COMPANY

ALLENPOINT will give you a bulldog grip at no premium in price!

Allen's scientific redesign of the cup diameter on set screws gives greatly increased resistance to *withdrawal* torque. You can count on Allenpoint Set Screws to stay tighter longer, under heavy strain and vibrations. This dependable premium performance of Allenpoints is yours to use without increasing the cost of manufacturing your products.

Uniform Class 3A Threads

Allenpoints' smooth, uniform threads prevent off-lead conditions like Fig. 1. With Allenpoints, you have full, even contact between the engaging flanks of the threaded members (Fig. 2) —and a tight friction lock over the entire length of the Allenpoint Set Screw.

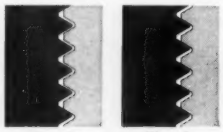
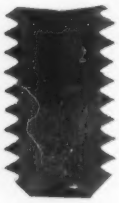


Fig. 1 Fig. 2

Strong, clean, deep sockets allow full wrenching leverage

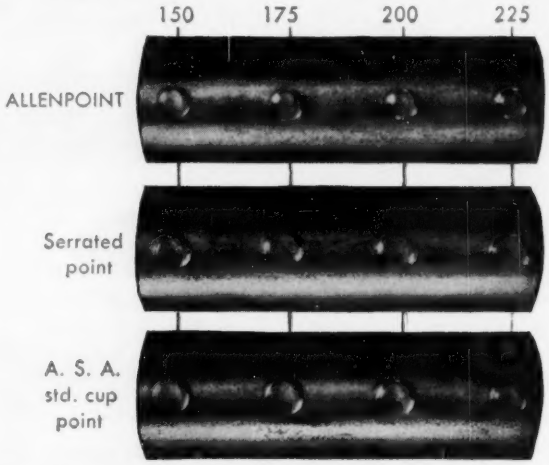


Sockets of Allenpoint Set Screws are cold forged to produce a deeper, smoother socket. No broach chips to interfere with proper seating of the key. This "pressur-forming" preserves the long steel fibers throughout the length of the screw—stronger walls allow maximum tightening torque.

One more full thread on ALLENPOINTS!

Allenpoint Set Screws have one more full thread than serrated point set screws. That means more holding power—especially important when you're using short lengths.

ALLENPOINT's performance compared for you



These actual-size, unretouched photographs show the cup pattern made by Allenpoints, serrated points, and A.S.A. standard cup point set screws in a 3/4" steel shaft. At each degree of tightening force, Allenpoints make a full circle pattern, penetrating deeper for greater holding power.

We'll be glad to send you more information and samples of Allenpoint Set Screws and other Allen Socket Screw products.

Stocked and sold by leading industrial distributors everywhere

ALLEN MANUFACTURING COMPANY
Hartford 2, Connecticut, U.S.A.

ALLEN HEAD HEX-SOCKET SCREWS

Garlock "makes the grade" with Galion... for over 30 years

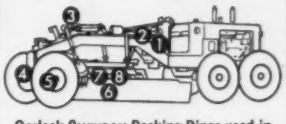
Now celebrating their 50th Anniversary, the Galion Iron Works and Mfg. Co., of Galion, Ohio is a leader in its field, and Galion Road Rollers and Motor Graders enjoy a reputation for long life and easy operation. For 30 years Garlock CHEVRON* Packings have been selected for the hydraulic cylinders of both Galion Road Rollers and Motor Graders. In fact, all eight models of the Motor Grader use CHEVRON Packings exclusively on hydraulic cylinders operating the blade, leaning front wheel, booster steering and various attachments.

The distinctive and exclusive CHEVRON design is extremely sensitive to pressure changes and ideally suited to use in shallow stuffing boxes. As pressures increase the CHEVRON Packing Rings automatically tighten to prevent leakage. As pressures decline the CHEVRON Rings instantly ease off permitting free operation without leakage. That's why cylinders using CHEVRON Packings require minimum attention and maintenance.

Exclusive CHEVRON is one more part of "the famous Garlock 2,000"... two thousand different styles of packings, gaskets, and seals for every need—the only complete line. It's one reason why your Garlock representative can provide you with unbiased recommendation. Call him today or write for CHEVRON Folder AD-115.

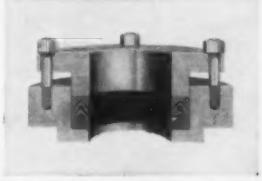
THE GARLOCK PACKING COMPANY, Palmyra, N.Y.

For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.



Garlock CHEVRON Packing Rings used in 8 hydraulic cylinders on Galion Motor Graders:

1. Left Blade Lift Cylinder
2. Right Blade Lift Cylinder
3. Scarifier Cylinder
4. Leaning Wheel Cylinder
5. Booster Steering Cylinder
6. Moldboard Shift Cylinder
7. Tilt Moldboard Cylinder Right
8. Tilt Moldboard Cylinder Left



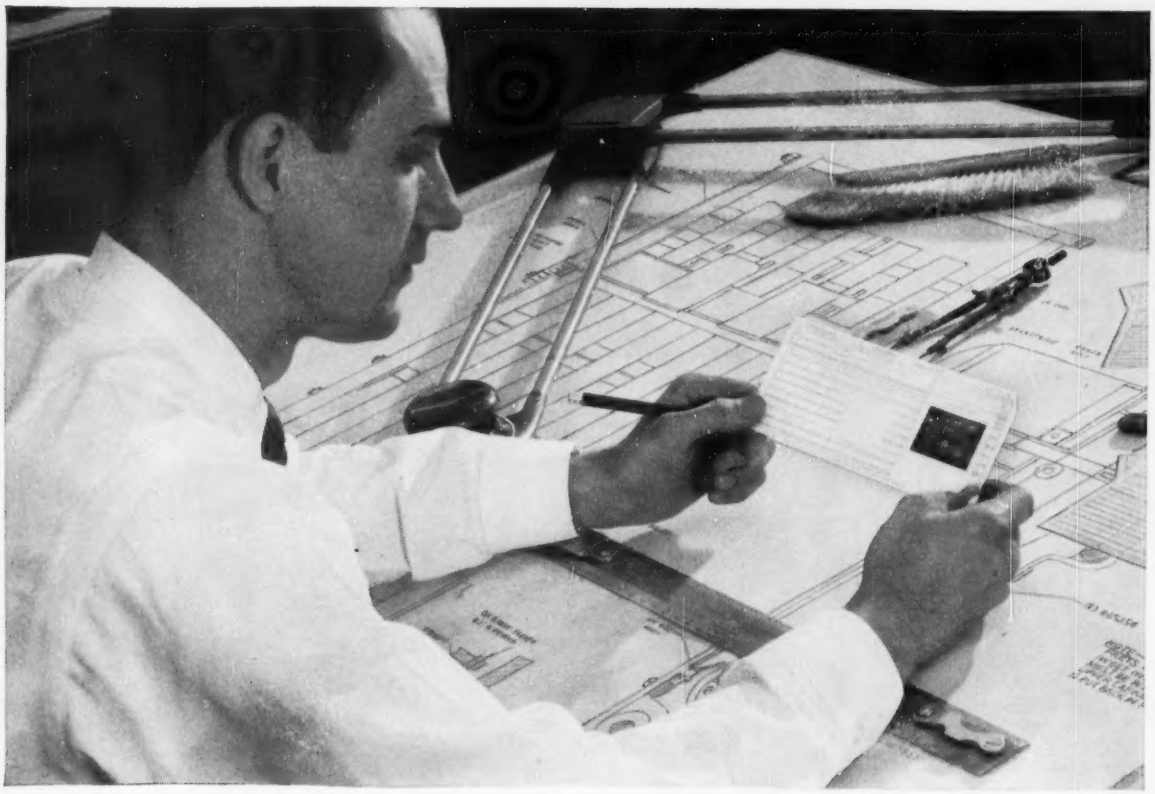
This design is entirely different from ordinary V-type packing. CHEVRON has an exclusive construction which assures the automatic action for which it is designed. Also permits the use of less packing in shallower stuffing boxes.

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Rubber Expansion Joints, Fluorocarbon Products

Circle 452 on page 19

*Registered Trademark.



Use of Recordak 35mm Microfilm in Filmsort aperture cards brings new efficiency to your drafting room

NEW RECORDAK PRECISION ENGINEERING DRAWING SYSTEM

Destined to change drafting room procedures the world over!

Important Recordak discoveries in 35mm microfilming techniques and quality control greatly increase the scope of aperture cards. Simplify filing, reference, printmaking, and distribution in all drafting rooms large and small.

Now, *for the first time*, engineering drawings, prints, specification sheets—all sizes, all ages, all colors—can be reproduced uniformly, without loss of detail, *on low-cost 35mm microfilm.*

Picture, if you will, a faded blueprint with white lines; a soiled tracing with gray lines; a mottled brown Van Dyke with yellowed lines; a spirit duplicator copy with purplish images: From this assortment of negatives and positives you get white on black *negative* 35mm copies—with needle-sharp line detail and amazingly uniform backgrounds. (Background densities are controlled within 2/10 of 1% on the A.S.A. neutral density scale.) And this magic is performed—not with 70 or 105mm film—but with low-cost Recordak 35mm microfilm.

The next step in the new Recordak System—putting one or more frames of these superb 35mm reproductions in punched, tabulating, or other standard cards—gives you an active drawing file which saves engineering time, steps up efficiency.

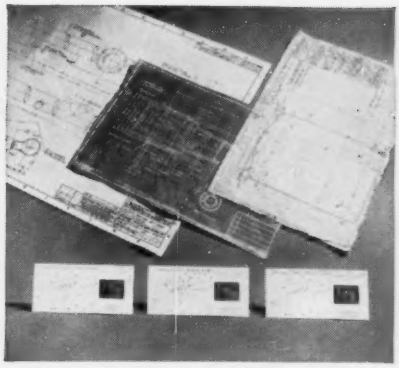
How Recordak System cuts costs

☐ ***Decks of cards replace acres of files.*** Now you can keep thousands of drawings at your fingertips in uniform trays. Save as much as 95% of floor space and cabinets now required for inactive or superseded drawings.

☐ ***Drawings can be filed according to sequence number***—impractical or impossible before when drawing size varied from small to large.

☐ ***Reference is faster.*** Your Recordak 35mm Filmsort aperture cards can be

Recent Recordak improvements in 35mm microfilming techniques and quality control make new system possible



Drawings and prints of all ages, sizes and colors are reproduced uniformly on Recordak 35mm Microfilm

Decks of cards replace acres of files—thousands of microfilmed drawings can be kept at the fingertips

checked immediately in a specially designed film reader, next to your drafting board.

☐ ***You get prints faster.*** Having aperture cards at your fingertips also pays off whenever prints are needed. Enlargement prints are made directly from the cards in seconds using photographic or electrostatic methods.

☐ ***Lowers distribution costs.*** Pays to ship Recordak Filmsort aperture cards —instead of blueprints—to branches, repair depots, subcontractors. They enjoy the advantages cited above. You speed distribution, slash mailing costs.

☐ ***Gives you low-cost protection*** Duplicate film copies can be made from the master film or aperture cards and vault-stored at low cost. An impossibility with bulky drawings.

Improves print quality

The quality of the Recordak 35mm film images is so exceptional that enlargement prints made from them will be as readable as the originals. You are invited to compare their quality with prints you are now getting from your original tracings or intermediates of any type.

Fills urgent need

In large companies and government agencies the problem of storing, distributing and protecting engineering drawing files is, of course, more acute than in the smaller ones.

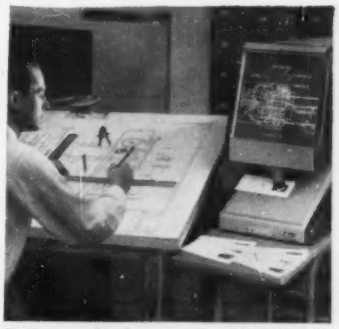
In these large organizations, further economies can be realized by correlating the use of Recordak Filmsort aperture cards with mechanized filing, sorting, duplicating and enlarging systems.

New system hailed by engineers and draftsmen

Already many well-known companies have launched programs employing Recordak's new system. You are cordially invited to make any comparison, to make any test. No obligation whatsoever.

Free booklet gives full details

Must reading for every engineer and draftsman . . . explains the new Recordak System in detail. Shows how you can bring its advantages to your drafting room using your own Recordak equipment and following Recordak procedures. Or by calling on Recordak's Technical Service Department to do the complete job.



Reference is faster—any microfilmed drawing can be checked immediately in a specially designed reader

Enlarged paper prints can be made in seconds directly from aperture cards

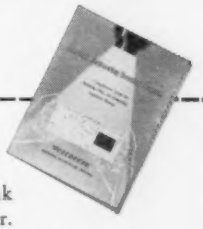
"Recordak" is a trademark

RECORDAK

(Subsidiary of Eastman Kodak Company)

originator of modern microfilming— now in its 30th year

MAIL COUPON TODAY



RECORDAK CORPORATION
415 Madison Avenue, New York City

Gentlemen: Send free booklet describing new Recordak Engineering Drawing System. No obligation whatsoever.

Name_____ Position_____

Company_____

Street_____

City_____ State_____

Circle 453 on page 19

You don't have to be over 21

to install and maintain

a Fenwal temperature indicating controller

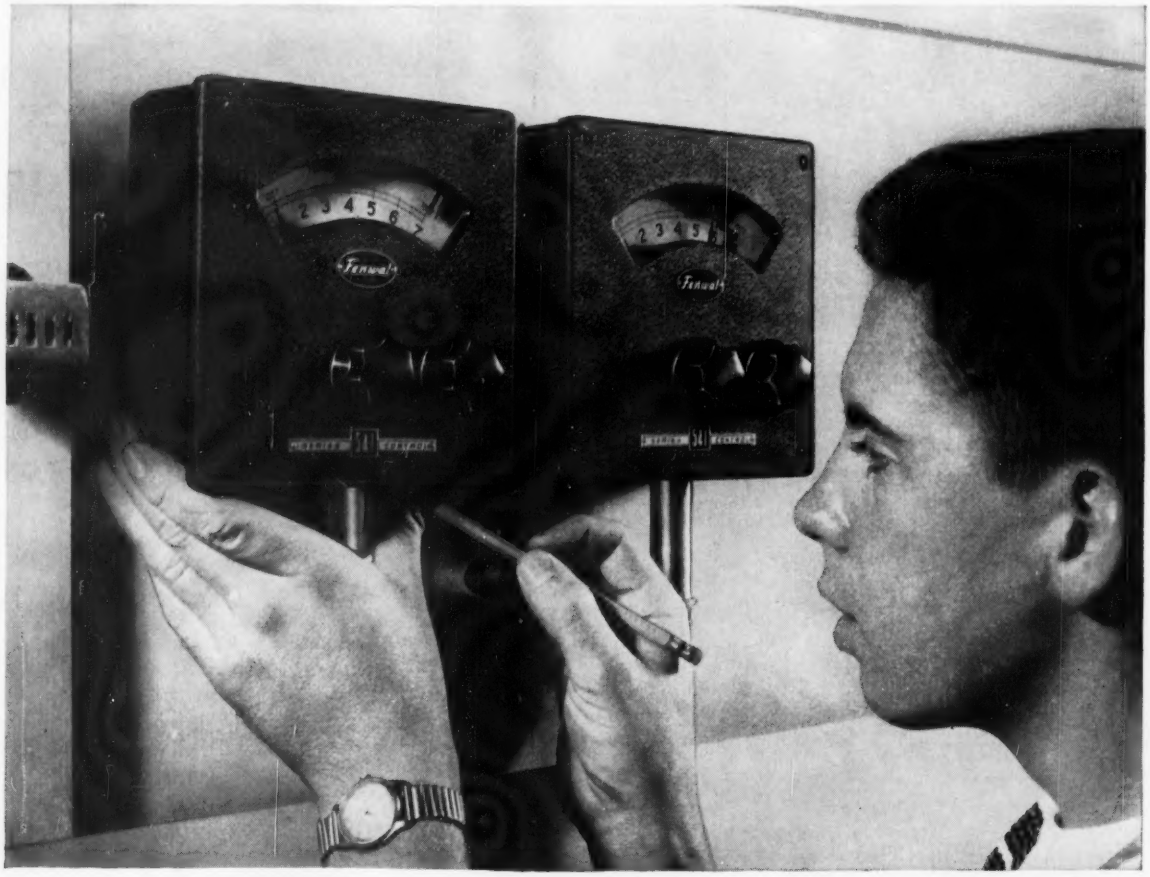
It really is a cinch for an untrained person to install and maintain Fenwal's 541 Temperature Indicator Controller. You don't even have to open the case to adjust it — even its snap switches can be easily replaced without disturbing the internal mechanism. *It's simple!*

In Fenwal's 541 all moving parts are in opposition — wear on one is automatically compensated for and the controller's high accuracy remains unchanged! *It's reliable!*

You can take your choice of temperature range, bulb styles, and one or two circuit controls, current ratings — even the color of the housing. There are literally hundreds of adaptations that can be made from stock! So you get a tailor-made, fit-to-order controller at a competitive price! *It's versatile!*

Drop us a line at Fenwal Incorporated, 1910 Pleasant Street, Ashland, Mass. and we'll send you our catalog MC-139 or our sales engineer, whichever you want.

This is our dual circuit model (we've got hundreds of others) which has two snap switches, each with a set point indicator, that actuates two circuits at pre-set temperatures. Housing in all Fenwal 541's meet NEMA and JIC specifications.

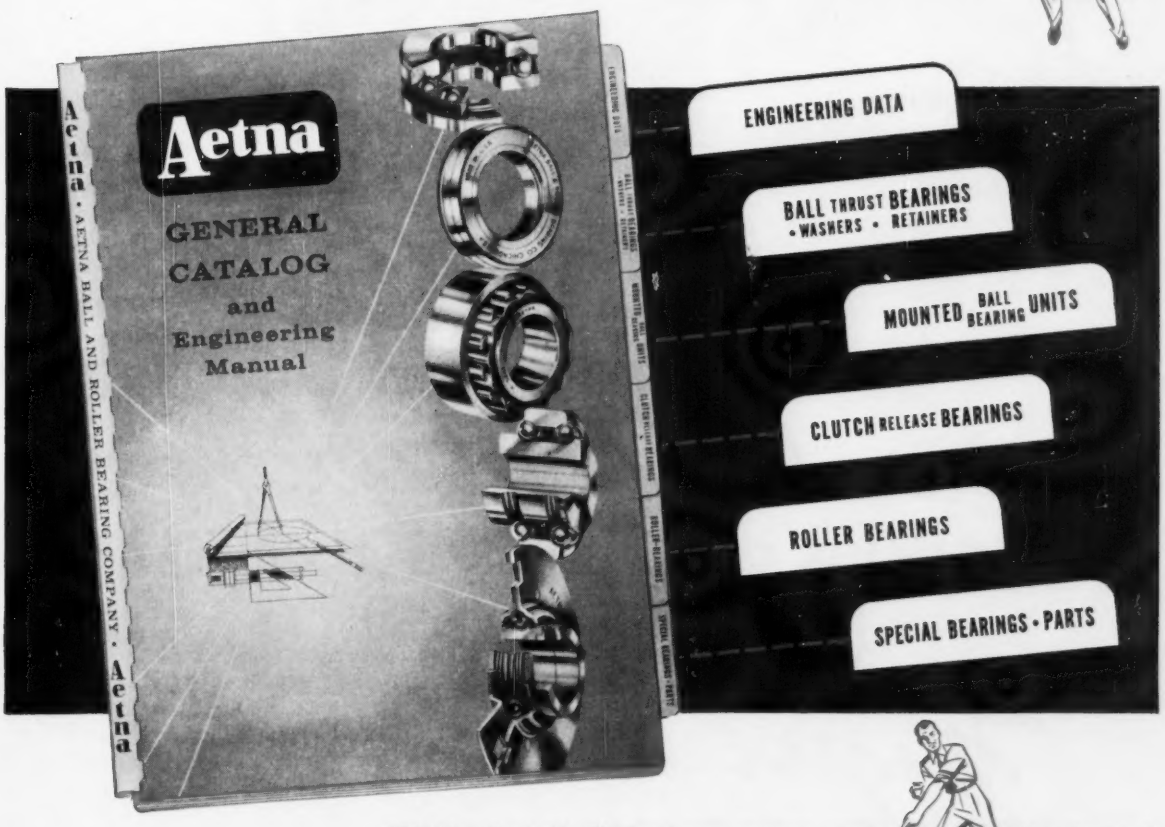


Fenwal CONTROLS TEMPERATURE . . . PRECISELY

Circle 454 on page 19

BRAND NEW...

...and there's a copy waiting for you!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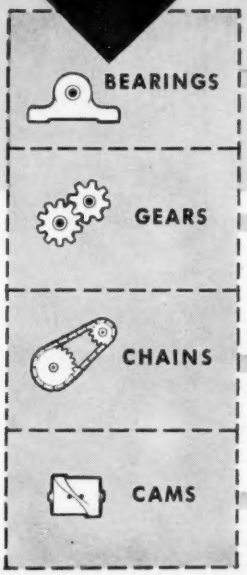
DIVISION OF PARKERSBURG-AETNA CORPORATION • 4600 SCHUBERT AVE., CHICAGO 39, ILL.

Circle 455 on page 19

MICRO-FOG
Lubro-Control Unit

Automatically...

Supplies a CONTINUOUS FILM of FRESH OIL for



Norgren

MICRO-FOG® LUBRO-CONTROL UNIT

A MICRO-FOG Lubro-Control Unit Automatically...

- Removes damaging solids and liquids from the air.
- Regulates the air pressure.
- Applies a continuous protective film of fresh air-borne oil to every bearing, gear, chain or cam on a machine.
- Provides just the right amount of oil—not too much, not too little—for the most efficient lubrication, holding machine wear to a minimum.
- Only one Norgren MICRO-FOG Lubro-Control Unit is required to completely lubricate a complex machine.

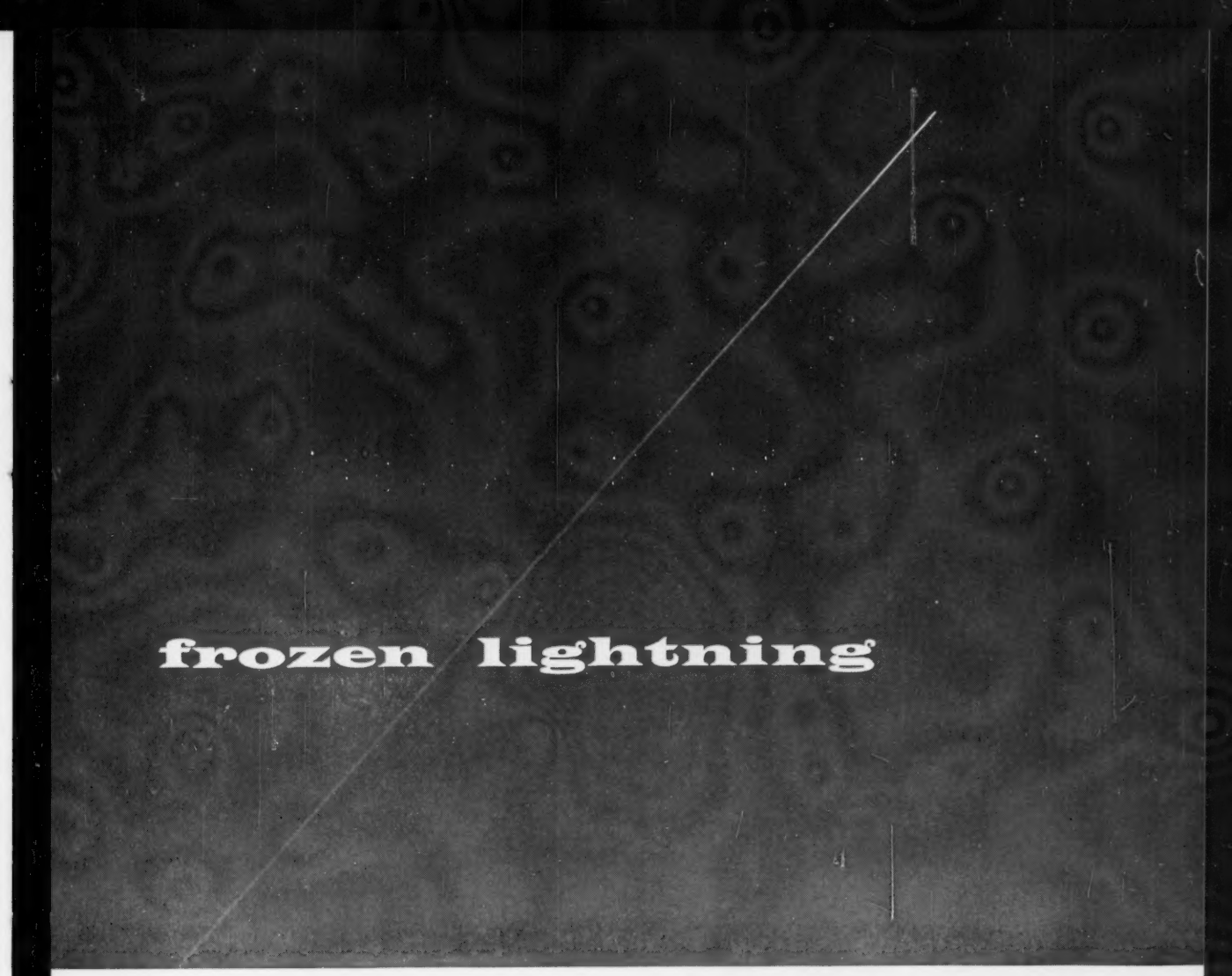
For complete details about the Norgren Lubro-Control Unit, call your nearby Norgren Representative listed in your telephone directory—or **WRITE FACTORY.**

Pioneer and Leader in Oil-Fog Lubrication Since 1930

C. A. NORGREN CO.

3442 SOUTH ELATI STREET • ENGLEWOOD, COLORADO

Circle 456 on page 19



The Germans called the upper-atmosphere trails of their V-2 rockets "frozen lightning". When the Mach 4-5 aircraft now under development fly at 80-90,000 feet and higher, we'll be seeing frozen lightning in our own skies.

Not freezing but heating will be the *real* problem at these ultra high speeds. At 3000 mph, the skin and many structural components will be heated to over 1000°F, temperatures too high for alloys now used. Needed: materials strong up to 1200-1300°F for structural forgings and other stressed parts.

Engine builders, fastener manufacturers and forge shops are handling similar requirements right now, with Carpenter alloys. These alloys have gained an enviable reputation for uniform high quality, ability to meet tough specifications consistently, improved forgeability and exceptional cleanness. Forging tolerances can be tighter. Finishes are better. Rejects are far fewer.

Design properties and fabrication instructions for these alloys are summarized in our new booklet, "Carpenter Alloys for Elevated Temperature Service". For your copy drop us a line on your Company letterhead. The Carpenter Steel Company, 120 W. Bern Street, Reading, Pa.

Carpenter STEEL

Improved alloys for elevated temperature service

Circle 457 on page 19

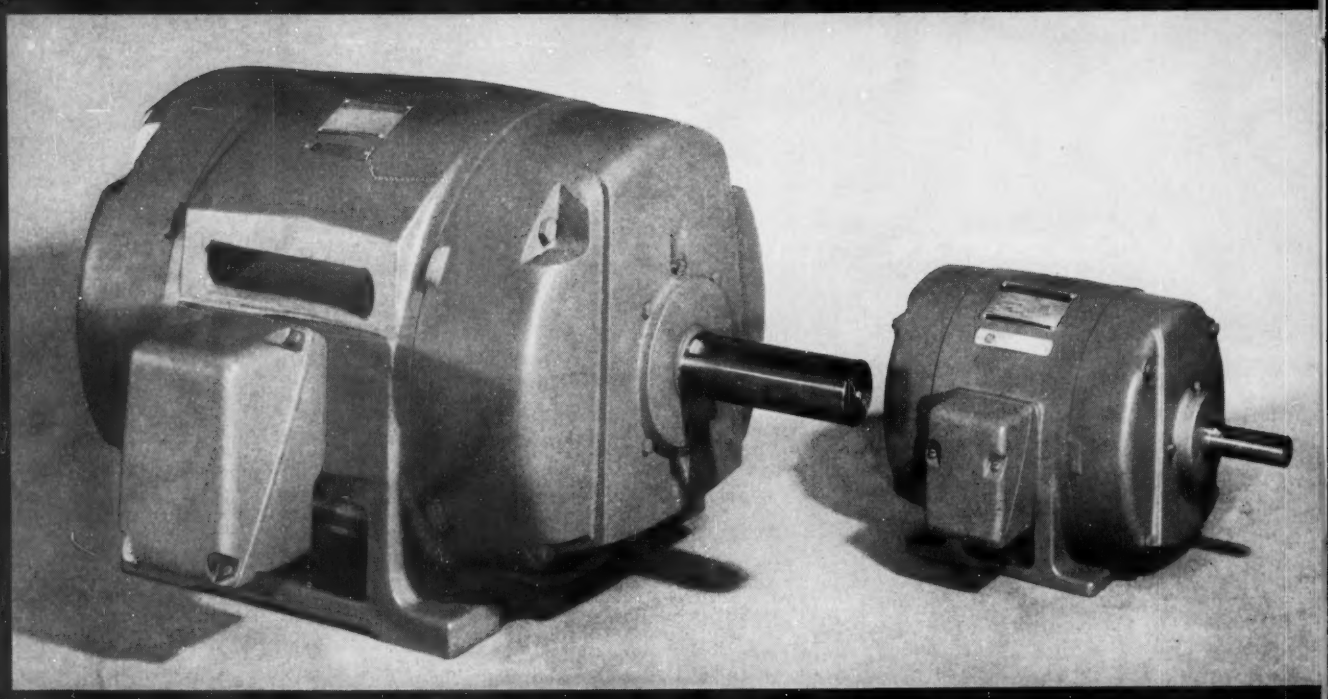
immediate shipment . . . all ratings

General Electric TRI 55 CLAD

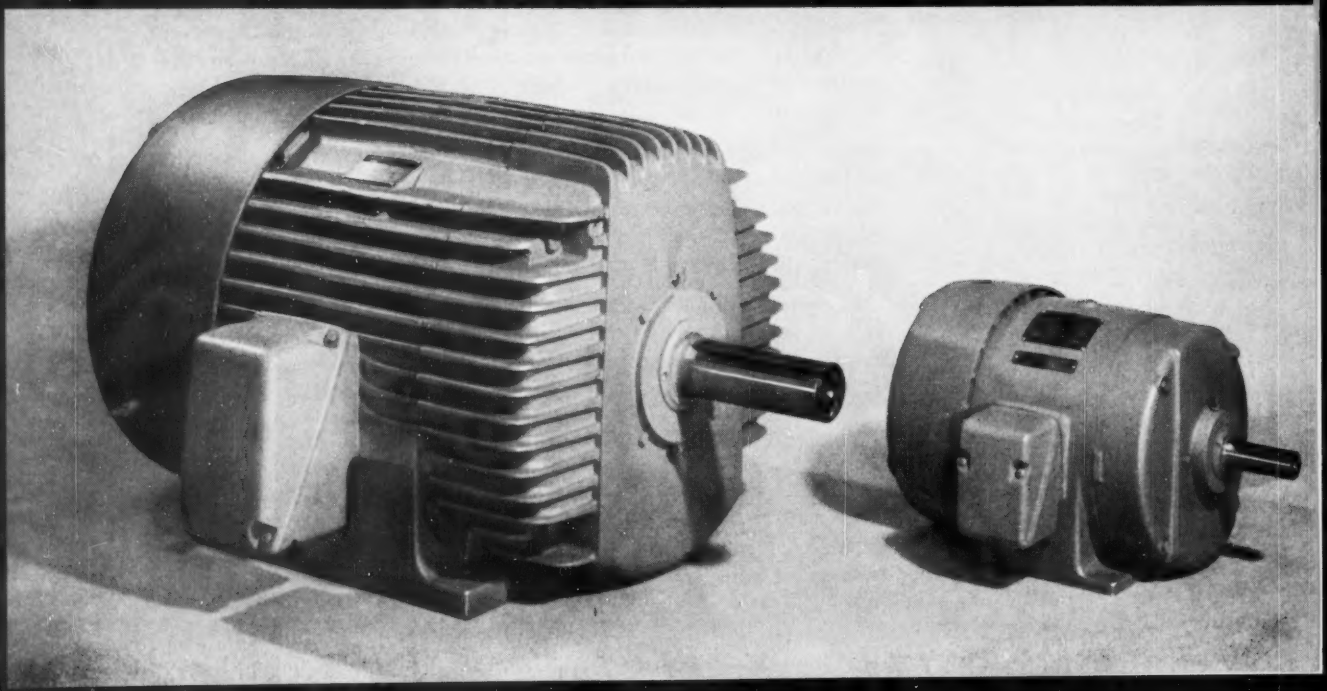
REG. U.S. PAT. OFF.

NOW UP

DRIPPROOF



TOTALLY ENCLOSED

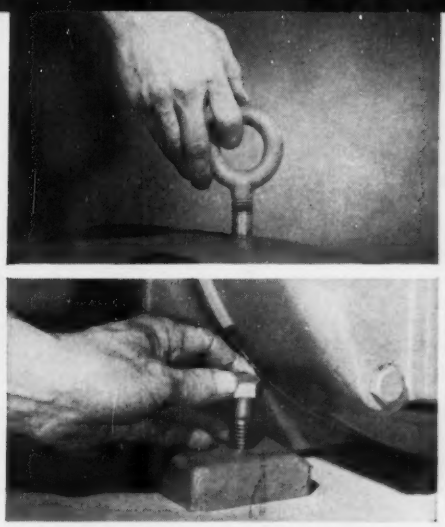


Motors in New NEMA Ratings

TO 125 HP

YEARS AHEAD BENEFITS

DESIGNED TO CUT COSTS—Up to 32% lighter and 50% smaller, new NEMA rated Tri-Clad '55' motors offer big savings on shipping, handling and storage costs. These more powerful, more compact motors permit big space savings on many machine designs.



DESIGNED FOR EASY HANDLING—Sturdy, forged eye bolts are supplied with new Tri-Clad '55' motors in larger ratings to permit easier motor handling. Provision for plenty of "wrench room" between motor feet and end shields cuts Tri-Clad '55' motor mounting time.

DESIGNED FOR EASY INSTALLATION—Perma-numbered leads simplify wiring and speed motor hook-up. Numbers are stamped on terminals and printed on every half inch of the Geoprene® lead covering. Leads are always identifiable even when taped or clipped.

FOR COMPLETE INFORMATION

FOR COMPLETE DETAILS on the new line of Tri-Clad '55' motors up to 125 hp, contact your local G-E motor distributor or the sales engineer at your nearby General Electric Apparatus Sales Office. You will get expert assistance in selecting and applying the right motor for your particular application.

FOR FREE SLIDE RULE—which lets you determine at a glance the weight and space-saving benefits of recently announced NEMA standards for larger motors—and for informative, free General Electric Tri-Clad '55' motor bulletin, please send attached coupon.

Section 891-6A
GENERAL ELECTRIC COMPANY
Schenectady 5, New York

Please send me the following publications:

☐ **FREE BULLETIN** (GEA-6602) describing the many advanced features of new Tri-Clad '55' motors up to 125 hp.

☐ **FREE SLIDE RULE** (GEN-148) to determine weight and space-saving benefits of new Tri-Clad '55' motors.

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Progress Is Our Most Important Product

Circle 458 on page 19

GENERAL ELECTRIC

Engineering problem:

Pressure-tight fastening of transit cases

The solution:

A specially modified LINK-LOCK

Applied Design Company engineers worked with Simmons to develop this successful LINK-LOCK application

Simmons LINK-LOCK, with design modifications developed in cooperation with the Engineering Department of Applied Design Company, Buffalo, New York, resolves special closure requirements in rigidly specified transit cases like the aluminum equipment container shown.

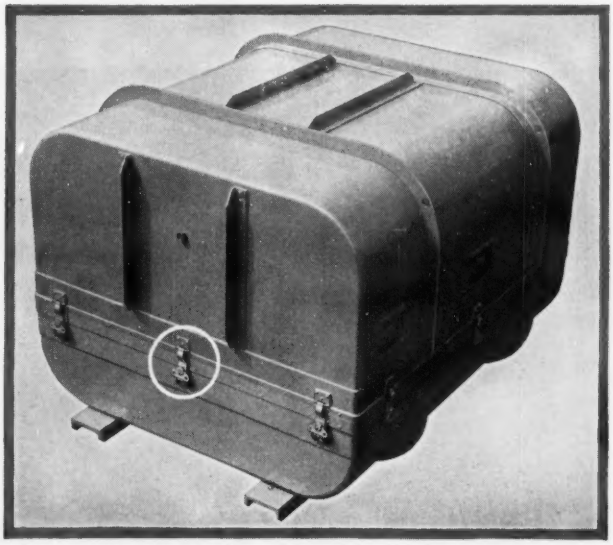
Here, the bowed LINK-LOCK engagement blade provides the double advantage of maintaining constant fastener pressure and permitting considerable mounting tolerance. This container is just one of many important products in which Applied Design specifies standard and special Simmons Fasteners.

Here's why LINK-LOCK is ideal for use on military cases produced to exacting specifications as well as on inexpensive commercial containers:

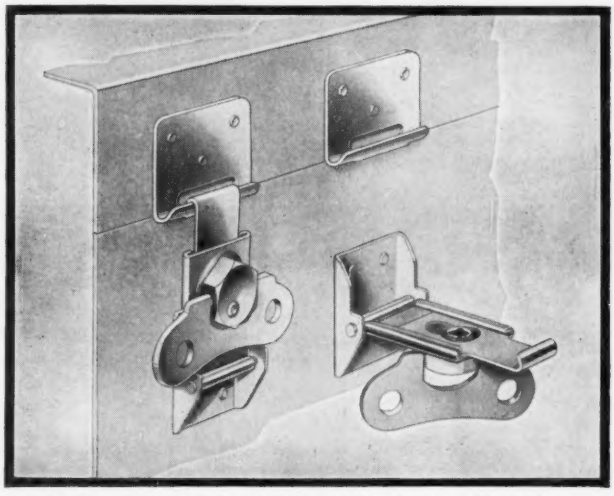
- Impact and shock resistant (positive-locking).
- High closing pressure with light operating torque...insures pressure-tight seals where required.
- Available in 3 sizes, for heavy, medium, and light duty.
- Compact design...lies flat against case even when unlocked.
- Opening and closing by wing-nut, screwhead, or hex nut.
- Flexible engagement latch design...can be varied to suit different conditions.

Also available: Spring-Loaded LINK-LOCK. Ideal for the less expensive containers where costs won't permit precision production. Spring provides take-up to compensate for set in gasketing, irregularities of sealing surfaces, and mounting inaccuracies.

SEND TODAY for the Simmons Catalog for complete information and engineering data on LINK-LOCK and other Simmons Industrial Fasteners. Engineering service is available; outline your particular fastening problems. Samples on request.



Twelve special loop-blade LINK-LOCK fasteners are used in this aluminum transit case designed by Applied Design Company.



Standard No. 2 LINK-LOCK (Medium-Duty). Available with screwhead, wing-nut as shown, or hex nut.

SIMMONS

FASTENER CORPORATION

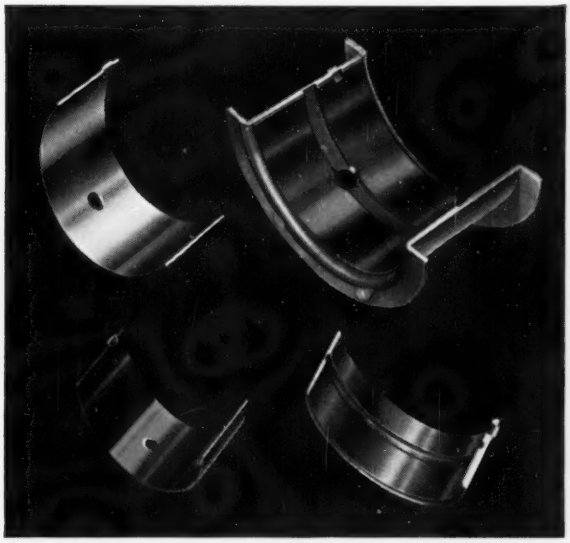
1756 North Broadway, Albany 1, New York

QUICK-LOCK • SPRING-LOCK • ROTO-LOCK • LINK-LOCK • DUAL-LOCK • HINGE-LOCK

Circle 459 on page 19

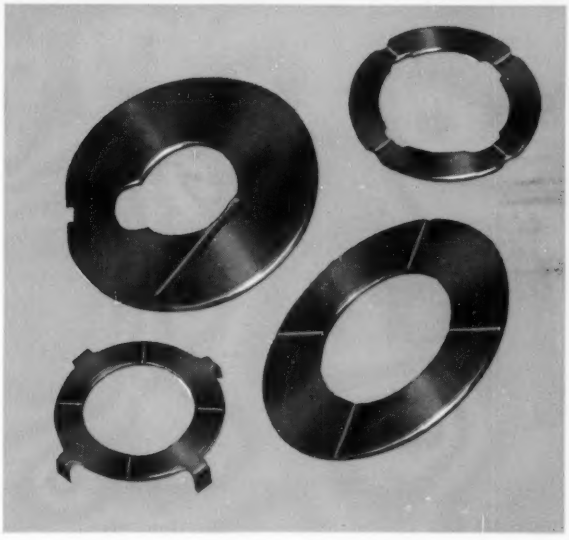
Three alloy linings meet 95% of engine bearing needs

Experience shows a steel back lined with tin- or lead-base babbitt or copper-alloy meets performance requirements.



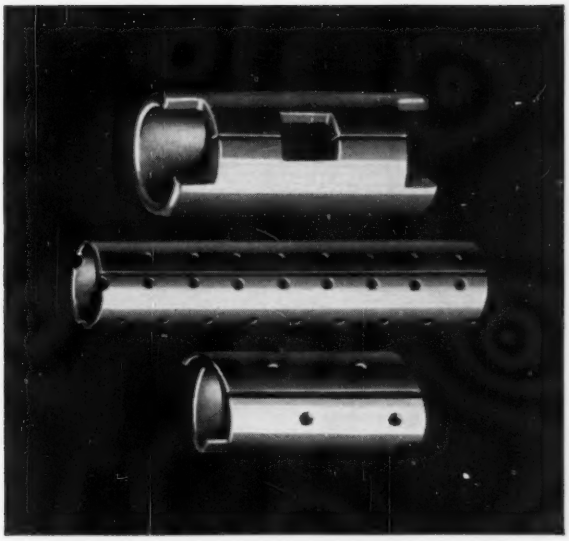
Bimetal and Plain Bushings offer substantial economies

Rolled split plain bronze, steel or aluminum; or steel lined with bronze, babbitt or copper-alloy. Many design variations possible, plus volume production economies.



Precision Thrust Washers in Bronze or Bronze on Steel

Cold rolled for heavy duty. Steel faced with copper-alloy on one or *both* faces. Nibs, lugs, coined oil grooves. Flat, spherical or special shapes. From 1″ to 6″ O.D.



Economical Spacer Tubes for Hundreds of Applications

Money-saving substitute for iron pipe, tubing or machined parts. Delivered ready for assembly, to exact dimensions—or can be brazed to other components.

FEDERAL Mogul SINCE 1899

FEDERAL-MOGUL DIVISION

FEDERAL-MOGUL-BOWER BEARINGS, INC., 11045 SHOEMAKER, DETROIT 13, MICHIGAN

RESEARCH • DESIGN • METALLURGY • PRECISION MANUFACTURING

Circle 460 on page 19

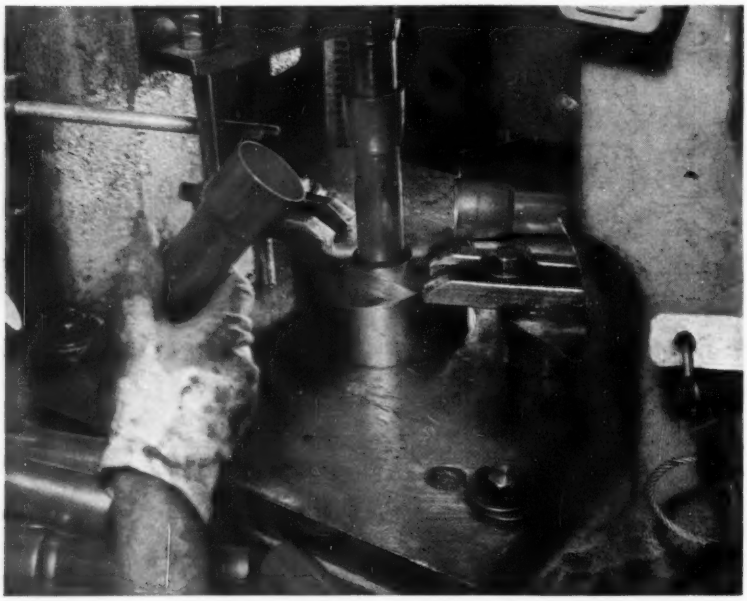
Circle 461 on page 19→

Steel's Strength, Copper's Fluidity (sealing ability) and corrosion resistance all are combined in Sterling Automotive Mfg. Co.'s use of Thomas copper-coated steel strip. By lubricating dies during punch press forming, copper coating boosted die life by 33%. The Chicago company turned to Thomas electro-coated strip to give its auto head gaskets extra strength needed for today's high-compression engines.

20 Million Shoe Horns a Year are made in Crawfordsville, Ind., plant of Steel Industries, Inc., where Thomas Strip saves up to 40% of production cost. From nickel-coated Thomas Strip, shoe horns get bright, shiny finish with only ball-burnishing after forming.

New Ways To Cut Costs With Thomas Strip

How Six Manufacturers Use These Production Ideas For Better Products



Ray-O-Vac Company saves $100,000 a year at its Clinton, Mass., Flashlight Division, by using Thomas copper-coated strip for flashlight cases. Compared to brass, Thomas deep-drawing strip is fabricated faster, requires less processing — also, copper coating lubricates dies and provides good chrome-plating base.

Manufacturers pictured on these pages chose Thomas Strip because it cuts costs, improves products—gives them higher profits and increased sales.

Pre-coated Thomas Strip is furnished ready for use with electroplated coatings of zinc, copper, brass, nickel, or chrome . . . or hot dip coated with lead alloy or tin . . . and coated with clear or colored lacquer.

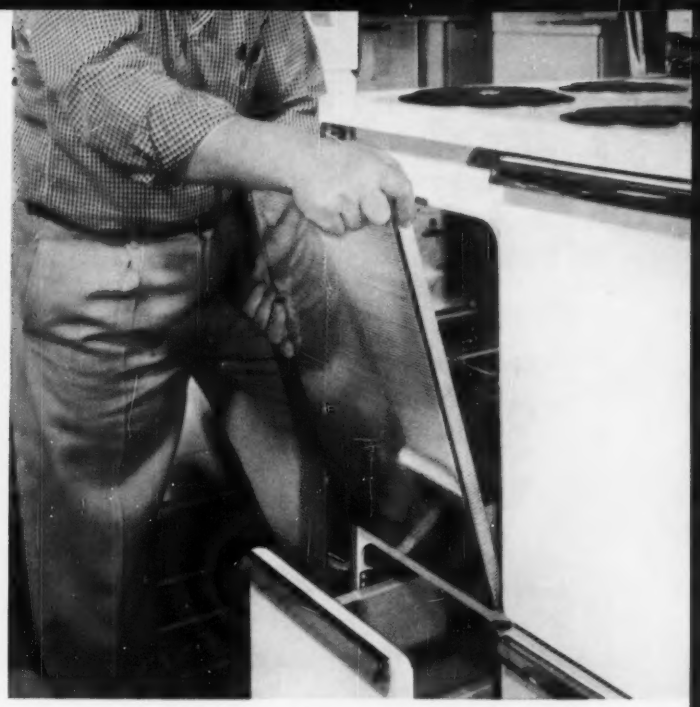
Uncoated Thomas Strip products include low carbon, alloy and high carbon spring steel grades. All are available in a wide range of sizes, gages, tempers and finishes.

You also can get cold rolled Thomas Strip plain or coated with a rolled-in pattern design of your choice.

All Thomas Strip products can save you money and enhance your product in six important ways:

• **Fabricates Easily**—coated steels stand fully as much fabrication as uncoated strip.

Increased Saleability and Profits followed Pioneer Can Co.'s switch from lithographed tin plate to brass-coated Thomas Strip with a rolled-in pattern design. Pioneer's waste baskets and decorative cans gained in durability, beauty and re-use value. They command a higher price now and return more profits.



General Electric's styling of its deluxe range made at Appliance Park calls for liberal use of pattern-rolled Thomas Strip. Deeply rolled rib design, satin chrome-coated, is used on oven door—adds distinctive modern touch to GE's Keyboard Ranges. Thomas offers many design patterns in plain or coated steels.

- **Longer Die Life**—most coatings lubricate dies, reduce wear and increase tool life.
- **Maximum Pieces Per Pound**—precision rolling to extremely close size tolerances gives more square feet of strip per ton.
- **Lower Plating Costs**—coatings can serve as final product finish or as base for further plating or painting.
- **Speeds Fabrication**—Thomas Strip coatings eliminate costly intermediate fabricating steps such as cleaning, buffing, even plating.
- **Steel's Strength and Economy**—are combined with beauty and utility of more expensive metals.

All the savings and benefits Thomas Strip specialties are giving to fabricators shown here are available to you. A national sales staff—familar with design and fabrication advantages of Thomas Strip is ready to serve you.

Write for samples, and additional cases of users' actual experiences with Thomas Strip Products. Do it today.

Stack 'n Add is another new product of Quaker Industries, Kenosha, Wisc. The smart sectional shelving gets strength, beauty and economy through use of Thomas brass-coated, buffed and lacquered strip for upright supports. Electro-coated Thomas Strip eliminates expensive pre-forming preparation, as well as costly plating.

Thomas Strip®

Division

Pittsburgh Steel Company

Grant Building · Pittsburgh 30, Pennsylvania

District Sales Offices:

Atlanta	Columbus	Detroit	New York	Tulsa
Chicago	Dallas	Houston	Philadelphia	Warren, Ohio
Cleveland	Dayton	Los Angeles	Pittsburgh	

Fourth Conference on Mechanisms

cosponsored by Purdue University and *Machine Design*

OCTOBER 14-15, 1957 • Lafayette, Indiana • PURDUE UNIVERSITY

PURPOSE of this continuing series of Conferences is to promote better understanding, design and application of mechanisms. All designers and engineers interested in the design and development of mechanisms are cordially invited.

ADVANCE REGISTRATION may be completed with the form below. The fee of $25.00 includes a banquet on October 14 and a luncheon on October 15, as well as a copy of the *Conference Transactions*.

HOUSING RESERVATIONS may be made with the Union Club on the Purdue campus by the form below. Rooms are also available at the Fowler Hotel in Lafayette (write direct), or those driving may prefer Morris-Bryant Motel, Cedar Crest Motel, or Green Acres Motor Court (all 2-4 miles north on U. S. 52).

PROGRAM

Session 1

MECHANISM DESIGN IN GERMANY
Kurt Hain, Kinematic Research Scientist, Braunschweig, Germany

Session 2A

CAM-FOLLOWER EQUIVALENT MECHANISMS
Prof. Harold A. Rothbart, The City College of New York

DESIGN OF A CONSTANT-LOAD CAM
John A. Carlson, Product Development, Teletype Corp.

A HIGH-SPEED INDEXING MECHANISM
Ray C. Johnson, Senior Design Engineer, Eastman Kodak Co.

Session 2B

KINEMATIC SYNTHESIS VIA COMPLEX NUMBERS
Prof. Richard S. Hartenberg, Northwestern Univ.

KINEMATIC ANALYSIS VIA COMPLEX NUMBERS
Prof. G. H. Martin, Michigan State Univ.

ALTERNATE FOUR-BAR MECHANISMS
Prof. A. S. Hall Jr., Purdue Univ.

Banquet

UNLOCKING HUMAN CREATIVITY
Dr. Richard W. Wallen, Senior Associate, Creelman Associates, Cleveland, O.

Session 3

ANTICIPATING DYNAMIC BEHAVIOR
Prof. J. B. Hartman, Lehigh Univ.

PREDICTING IMPACT FORCES
Ray C. Johnson, Senior Design Engineer, Eastman Kodak Co.

LINKAGES USING RACKS AND PINIONS
Erwin P. Pollitt, Senior Research Engineer, Armour Research Foundation

Session 4

THE DOUBLE-CRANK LINKAGE
Kurt Hain, Kinematic Research Scientist, Braunschweig, Germany

DWELL LINKAGES VS. CAMS
Prof. Thomas P. Goodman, Massachusetts Institute of Technology

Mail to: MECHANISMS CONFERENCE, Comptroller's Office (Conferences), Purdue University, Lafayette, Ind.

233.807

ROOM RESERVATION

Please reserve in the Union Club the accommodations checked:

Nights: Oct. 13 ☐ Oct. 14 ☐

Single Bed—Bath ☐

If necessary, will share twin-bed room with another Conference member ☐

Twin Beds—Bath ☐

Room will be shared by _____

Please send confirmation:

Name _____

Company _____

Address _____

CONFERENCE REGISTRATION

The following persons plan to attend the Mechanisms Conference, October 14 and 15, 1957 (name and title, please):

Fee enclosed

_____ ☐

_____ ☐

_____ ☐

$_____ is enclosed for the registrations checked at $25 each. (Make checks payable to Purdue University.)

☐ Fees will be paid at registration time.

Name _____

Company _____

Address _____

NEW MODELS WITH NEW FEATURES
new advanced engineering . . new styling . . . new "Crown Control" for Choke-Speed-Stop.

(Illustrated is the Crown Model 88-H — 2¼ hp with Crown Control)

Briggs & Stratton 4-cycle engines are No. 1 in use throughout the world

YEAR after year, more equipment for home, farm and industry is powered by Briggs & Stratton 4-cycle engines (to 9 hp) than by any other make.

This overwhelming acceptance is based on the proven record of Briggs & Stratton engines for dependable, trouble-free, long-life performance.

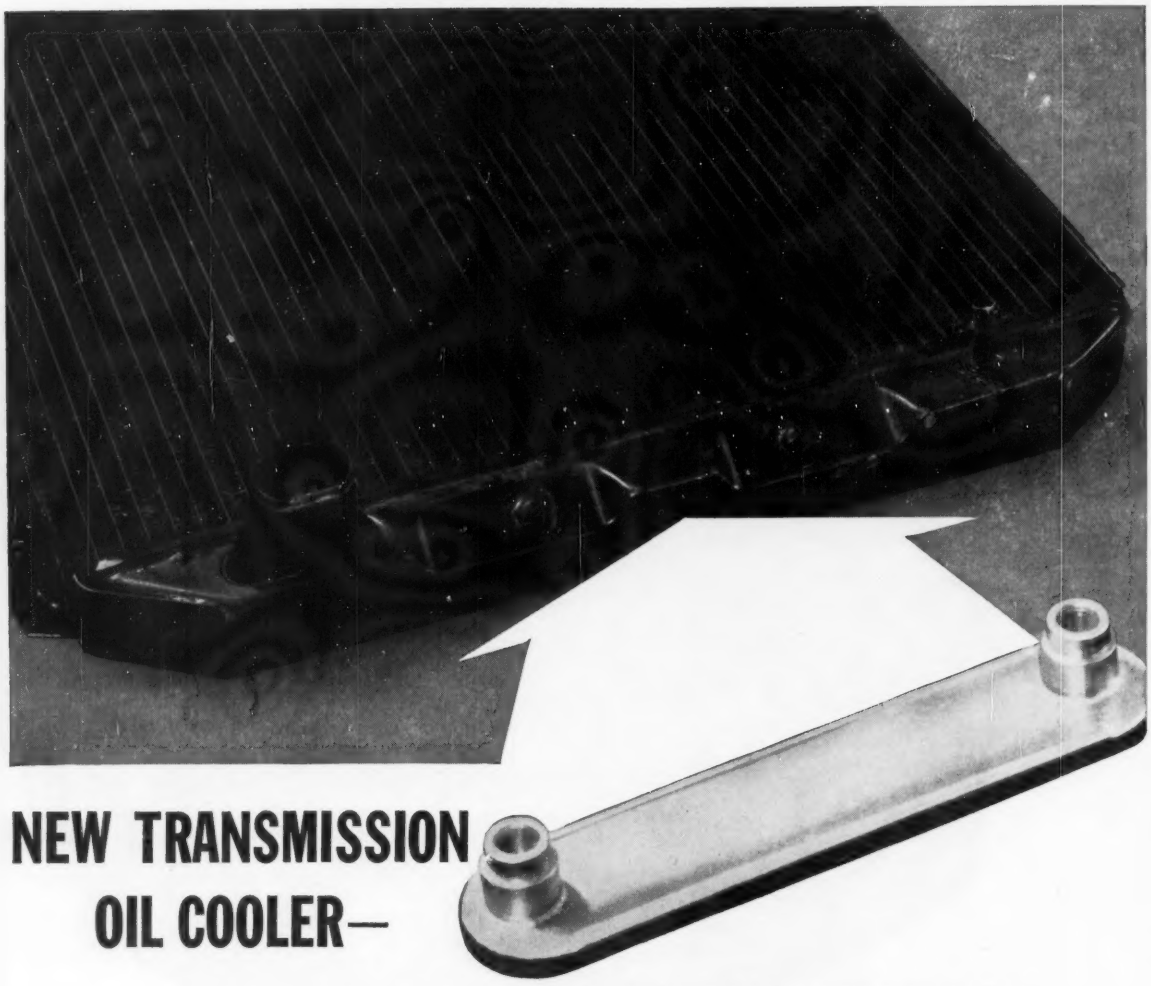
Put this engine acceptance — this demand — into the equipment you're designing. And — to save board time, money and modification headaches — you're invited to utilize Briggs & Stratton's consulting engineering service.

Briggs & Stratton also maintains a top-flight, world-wide network of over 9,000 authorized service dealers — further protection for your product's good name.

Briggs & Stratton Corp.
Milwaukee 1, Wisconsin

WORLD LEADER, TOO, IN AUTOMOTIVE LOCKS, KEYS AND RELATED EQUIPMENT

Circle 462 on page 19



NEW TRANSMISSION OIL COOLER—

another First for ALLEGHENY STAINLESS

Over 70% of today's cars are powered with automatic transmissions. Fine for the motorist, but new problems for the designer. Transmission oils zoom to 300 degrees and must be cooled.

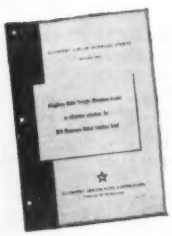
Solution? Mount a small, efficient heat exchanger within the lower tank of the radiator, as shown above. Make it able to stand wide temperature differentials—surrounding cooling water from 0° to 180°; searing oil of 300°. Make it corrosion proof—against all types of water, all varieties of anti-freeze compounds, dirty, hot oil. Since it's tucked inside the radiator, make it strong and maintenance-free.

Allegheny 430 Stainless Steel has proved itself to meet all these design objectives. And it actually reduced unit cost over other materials while still improving performance. The ductility and corrosion resistance of this straight chromium stainless make it a natural for this type of application.

Perhaps *your* product could be improved by a switch to Allegheny 430. It costs less than chromium-nickel stainless grades, it's always readily available, not subject to nickel shortages. To find out how Allegheny 430 Stainless can help you, write for the Technical Bulletin described below or call the Allegheny Ludlum Sales Office nearest you.

Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.

WSW 8782



Write for this 16-page Technical Study that describes alternate selections available for the Chrome-Nickel Stainless Steels. Gives properties, fabrication data, etc.

ADDRESS DEPT. MD-93

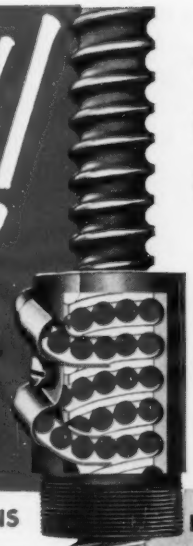
Make it BETTER and LONGER LASTING with

ALLEGHENY STAINLESS

Warehouse stocks carried by all Ryerson steel plants

NOW!

WHETHER YOU WANT TO MOVE 2 POUNDS 2 INCHES, OR 10 TONS 10 FEET—FORGET ACME SCREWS, HYDRAULICS, PNEUMATICS, CABLES AND PULLEYS



THE HIGH-PERFORMANCE LOW-COST ACTUATOR FOR VOLUME PRODUCTS

You can Actuate it Smoother, Simpler, Surer, Speedier and Usually Cheaper with the World's Most Efficient Roto-Linear Device

TYPICAL APPLICATIONS

- Automatic Garage Doors
- Automobile Seat Adjusters and Window Lifts
- Barber and Beauty Chairs
- Bumper Jacks
- Circuit Breakers
- Convertible Top Lifts
- Die Table Positioners
- Drill Presses
- Hospital Beds
- Lifters and Lift Trucks (Lift Tables)
- Marine Steering Gears
- Welding Machines

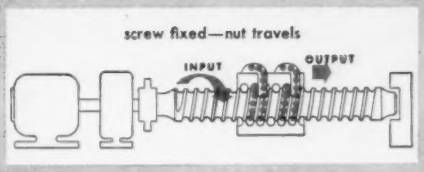
7 STANDARD SIZES

Ball Circle Diameter	Ball Size	Lead	Attaching "V" Thread Size
.375	.0625	.125	.664-32
.631 (R & L)	.125	.200	5/16"-16
1.000	.15625	.250	1.563-18
1.171	.28125	.41304	1.967-18
1.500	.34375	.47368	2.548-18
2.250	.375	.500	3.137-12
3.000	.500	.660	4.325-12

FREE ENGINEERING HELP

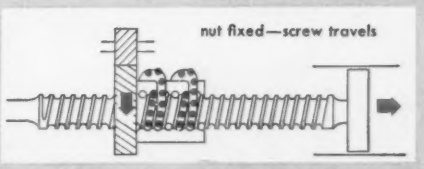
If you are currently using some other method of actuation—or think that the b/b Screw could improve the performance and sales appeal of your product, but are not sure how to apply it—let's get our heads together. Experienced Saginaw engineers, who have solved thousands of actuation problems, are at your service without obligation. Just write or phone us your requirements—or fill in and mail the handy coupon below.

BETTER ACTUATION with LOW POWER, LOW COST!



FORWARD: When rotary motion is applied to the screw, the b/b nut is driven along the axis of the screw, changing rotary motion to linear motion with over 90% efficiency.

FORWARD: When rotary motion is applied to the b/b nut, the screw is driven along its longitudinal axis, changing rotary motion to linear motion with over 90% efficiency.



GIVE YOUR PRODUCT THESE PROFIT-BUILDING PRODUCTION AND SALES ADVANTAGES:

1. With friction almost eliminated, the b/b Screw has a *guaranteed* minimum efficiency of 90%—performs up to 6 times better than acme screws.
2. Because of its far greater efficiency, the b/b Screw requires far less torque—saves up to 85% on operating power or manual effort.
3. The b/b Screw is smaller and lighter than comparable units; permits smaller motors and gear boxes; often eliminates clumsy auxiliary parts.
4. Smooth, almost frictionless operation assures long, troublefree b/b Screw life . . . even in extreme temperatures and with lack of lube!

Saginaw b ROLLED THREAD b Screw

WORLD'S MOST EFFICIENT ROTO-LINEAR DEVICE!

SEND TODAY FOR FREE 36-PAGE ENGINEERING DATA BOOK . . .
or see our section in Sweet's Product Design File

Saginaw Steering Gear Division
General Motors Corporation
b/b Screw and Spline Operation
Dept. 11H, Saginaw, Michigan

Please send new engineering data book on Saginaw b/b Screws and Splines to:

NAME_____

COMPANY_____ TITLE_____

ADDRESS_____

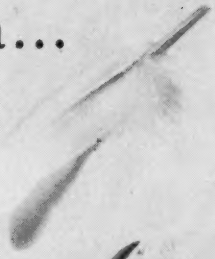
CITY_____ ZONE____ STATE_____

SAGINAW STEERING GEAR DIVISION OF GENERAL MOTORS • SAGINAW, MICHIGAN

WORLD'S LARGEST PRODUCER OF BALL BEARING SCREWS AND SPLINES

Circle 464 on page 19

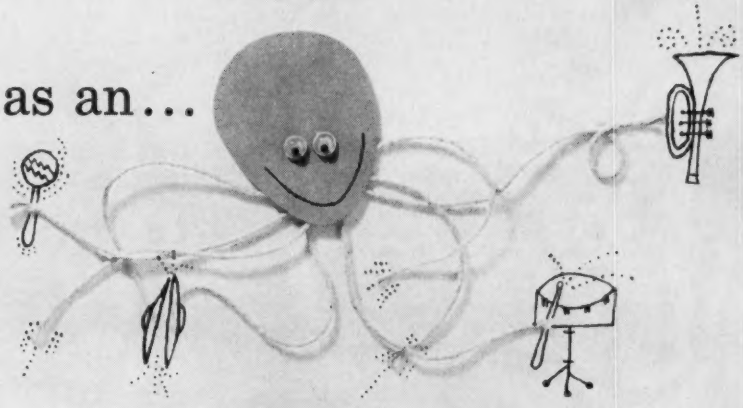
What's light as a...



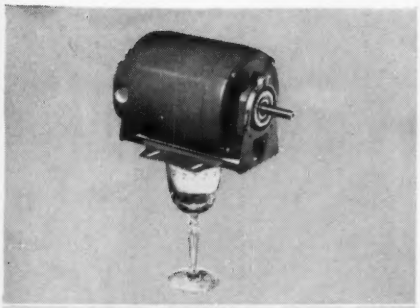
strong as a...

quiet as a...

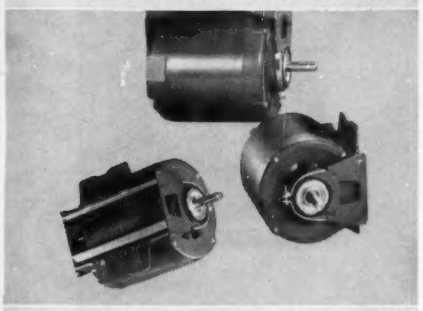
versatile as an...



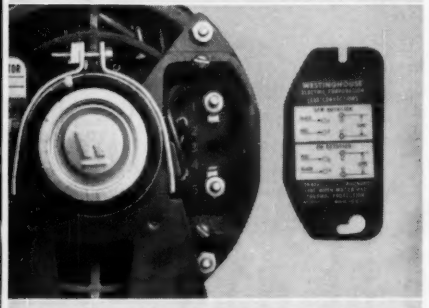
The 48·frame motor by Westinghouse!



Light as a feather . . . by up to 50%!



Powerful . . . mounted in any position!



Versatile . . . modern terminal board!

Easy to mount . . . threaded conduit hole!

Dependable . . . because it's Westinghouse!

What do you look for in an FHP Motor?

Whether you are a manufacturer, designer, buyer or engineer, there are certain features you look for when you buy fhp motors. You want a motor that is light . . . powerful . . . compact . . . quiet . . . and long lasting.

These are just a few of the features you get in 48-frame motors by Westinghouse! Feature by feature, there are no finer motors on the market! Don't take our word for it . . . compare. Here are the facts . . .

Fact 1: The Westinghouse 48-frame is up to 50% *lighter* than motors of comparable power! For *you* this means lighter equipment, reduced shipping costs.

Fact 2: The Westinghouse 48-frame gives you *true* all-position mounting. Positive oil return system provides excellent lubrication in any position.

Fact 3: The Westinghouse 48-frame gives you spade mounting (plug-in), standard terminal stud connections, and shur-plug for changing rotation.

Fact 4: The Westinghouse 48-frame threaded conduit hole assures faster assembly on your production lines, fewer connector parts and *positive* connections.

Fact 5: The Westinghouse 48-frame *is Westinghouse!* This distinctive tag is your guarantee of quality, performance, and long life.

Want More Facts? Call your nearest Westinghouse sales engineer, or get your copy of the 48-frame booklet giving all the features in detail. Just fill out and mail this coupon . . . J-03034

YOU CAN BE SURE . . . IF IT'S

Westinghouse

Small Motor Division, Lima, Ohio.

WESTINGHOUSE ELECTRIC CORPORATION
Small Motor Division, P. O. Box 566
Lima, Ohio

Send me your 48-frame booklet.

Name_____

Title_____

Company_____

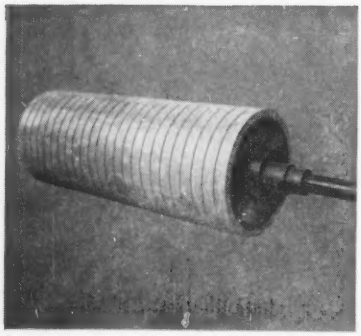
Address_____

City_____ Zone_____ State_____

Circle 465 on page 19

before pan or can...

Synthane laminated plastics are at work



Synthane-covered tin plate rolls last three times as long as other materials because of resistance to acids and surface toughness.

Few industries escape the multiple benefits of Synthane laminated plastics. The food industry puts Synthane to work as star wheels for bottling equipment, bread slicing guides as oil-less bearings in processing of sugar syrups and even in the tin-plating operation of metal containers.

Resistance to moisture, anti-friction characteristics, chemical and wear resistance are but a few of the reasons why Synthane is at work in this vital industry.

Synthane laminates combine in varying degrees—depending on which of the 30 or more grades you use—many mechanical, electrical and chemical properties hard to find combined in any other material.

You can buy Synthane in sheets, rods, tubes. If you prefer, your part can be supplied fabricated to your specifications. Send for our complete catalog for full information.

Synthane Corporation, 5 River Road, Oaks, Pa.

EASILY MACHINED

DIELECTRIC STRENGTH

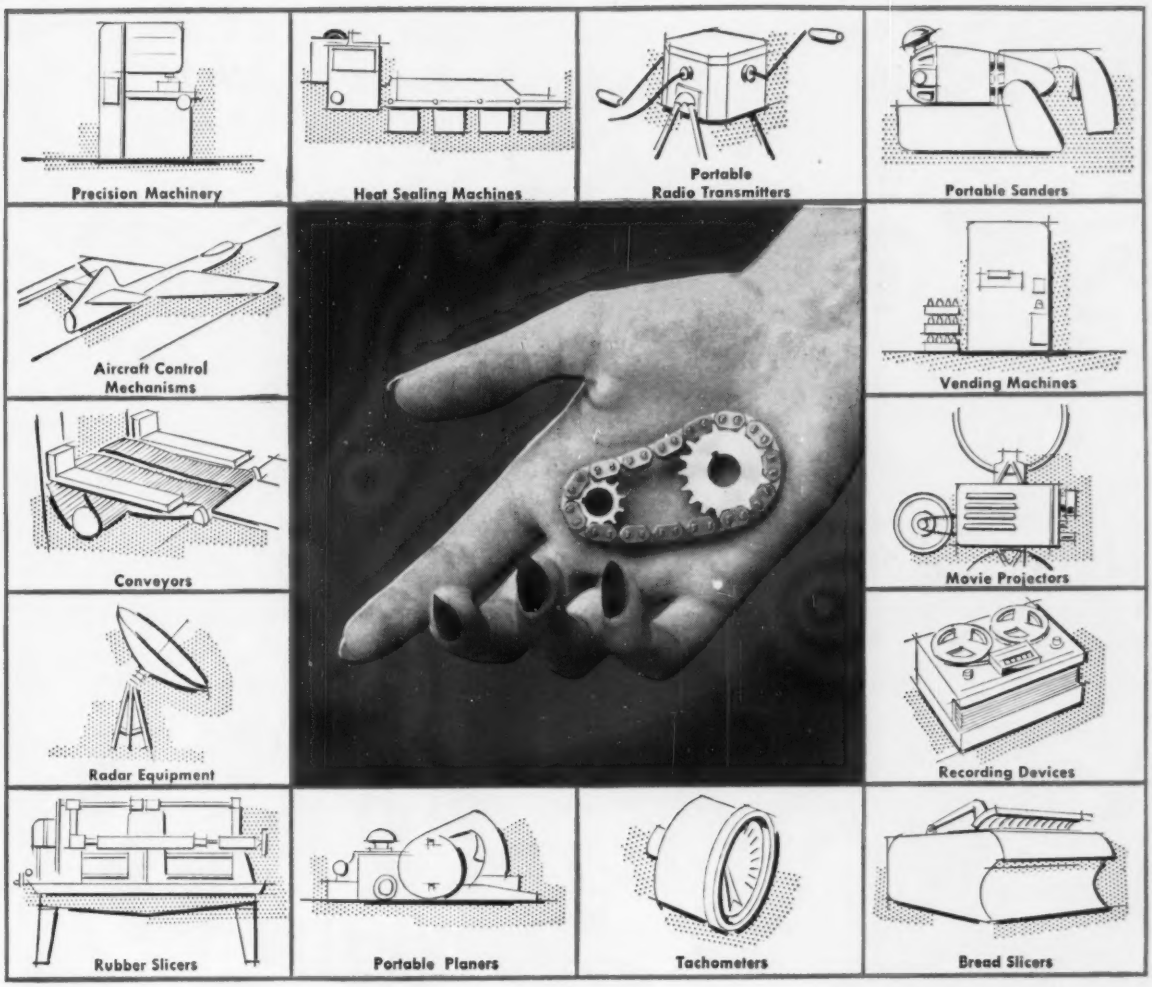
CHEMICAL RESISTANCE

WEAR RESISTANCE

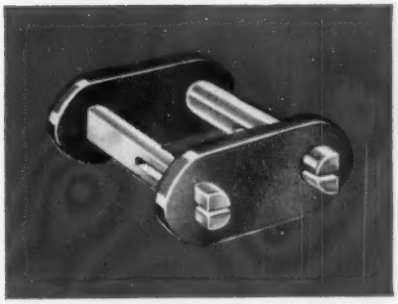
SYNTHANE . . . industry's unseen essential.

SYNTHANE CORPORATION, 5 RIVER ROAD, OAKS, PA.

Circle 466 on page 19



MORSE'S TINIEST CHAIN GIVES POSITIVE DRIVES UP TO 10,000 RPM . . . AND IN LIMITED SPACE!



EXCLUSIVE!

Patented coupling link makes assembly and removal of Morse 3/16"-pitch Silent Chain easy, permits design of fixed center drives without assembly problems. Your Morse distributor can supply you with exact lengths needed; or you can buy chain in bulk, cut it to size, assemble it yourself with easy-on coupling links.

Trying to get more components into less space? Morse 3/16"-pitch Silent Chain helps you do it—often saves you money, too!

Tiny, but with the strength of steel, these highly efficient drives transmit power as smoothly as a belt at speeds up to 10,000 rpm. Split-second precision of drive frequently permits replacement of costly gears.

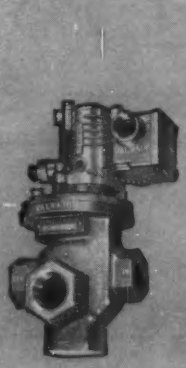
You can get Morse 3/16"-pitch Silent Chain in every standard style: shroud, center guide, or duplex; special chain materials are available for use in corrosive or extremely wearing conditions. For skilled engineering help on power transmission in limited space, call your local Morse distributor today. He's listed in the Yellow Pages under "Power Transmission." Or write: *MORSE CHAIN COMPANY, DEPARTMENT 6-97, ITHACA, NEW YORK; Export Sales: Borg-Warner International, Chicago 3, Illinois.*

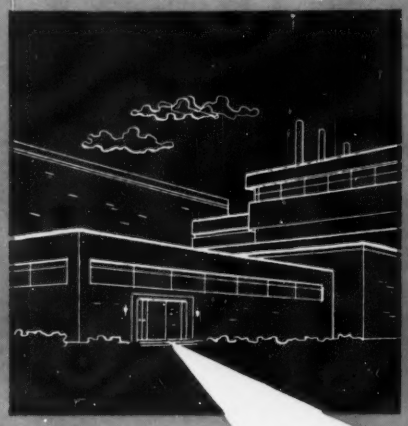
IN POWER TRANSMISSION
THE TOUGH JOBS COME TO

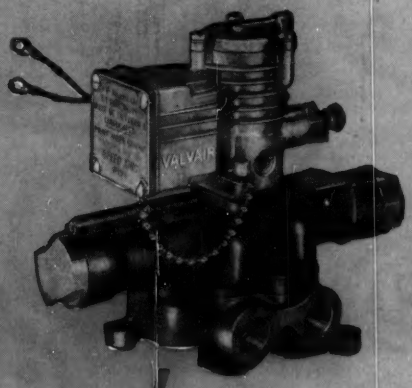
MORSE

*Trademark

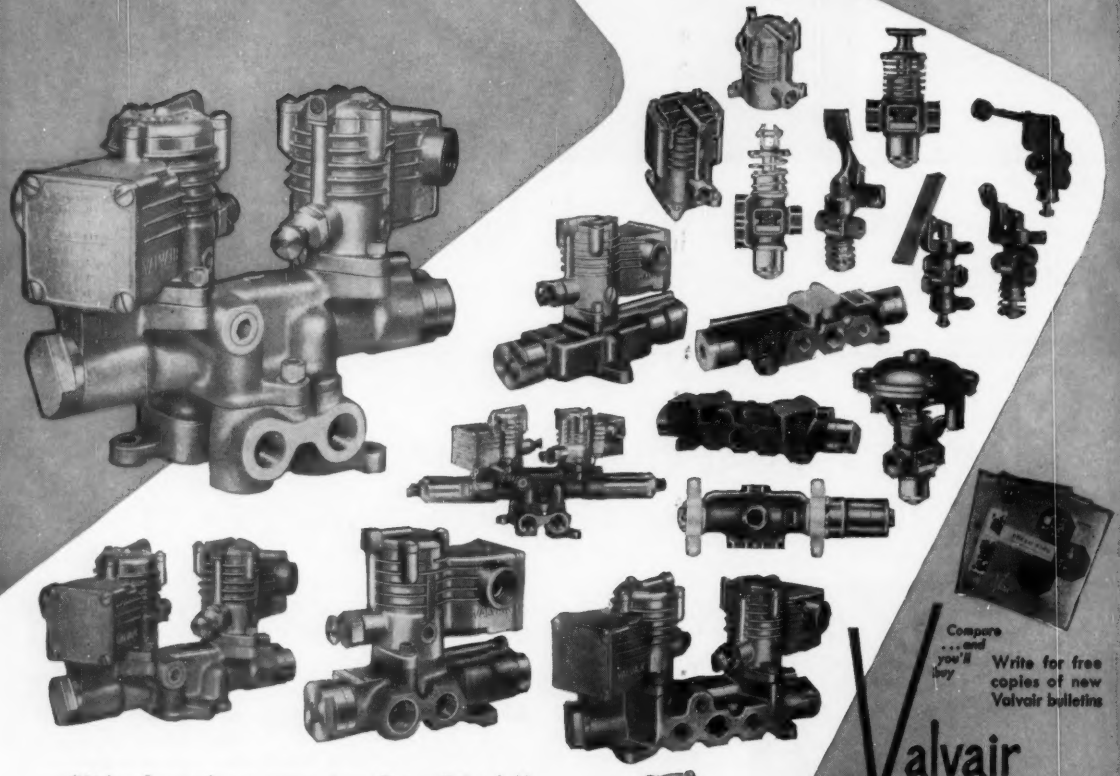
Circle 467 on page 19







Immediate delivery from stock . . . that's Valvair



Compare . . . and you'll buy

Write for free copies of new Valvair bulletins

Valvair

If it's valve *service* you want—immediate, off-the-shelf delivery—compare . . . and you'll buy Valvair. For we carry *in stock* one of the widest ranges of valves in the industry . . . a type and size for virtually any application involving air, vacuum and hydraulic operation.

If it's valve *performance* you want, Valvair has it there, too. For example, users report that Speed King valves are still delivering satisfactory performance after 25 million cycles.

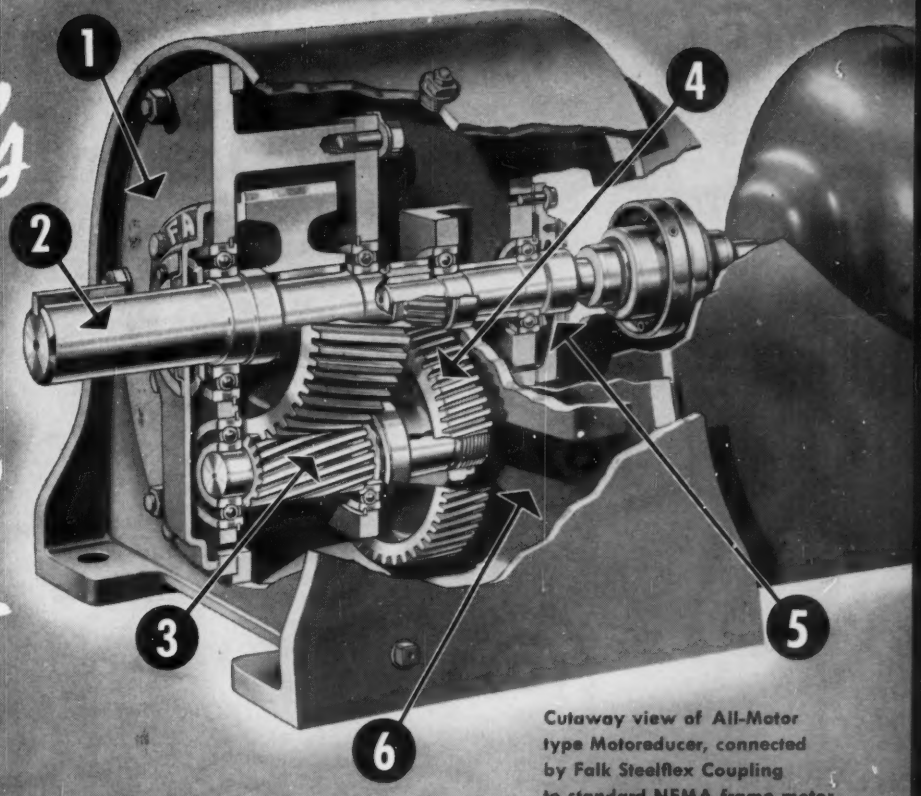
Check your valve requirements critically. Check performance requirements, features, materials, guarantee, delivery—and you'll specify Valvair. And Valvair's stock shelf is almost as near as your telephone. Valvair Corporation, 454 Morgan Avenue, Akron 11, Ohio.

AA-3248

Representation in: Baltimore • Birmingham Boston • Buffalo • Charleston, W. Va. Chicago • Cleveland • Cranford, N. J. Dayton • Denver • Detroit • Eureka, Calif. Grand Rapids • Houston • Indianapolis Kansas City, Mo. • Logansport, Ind. • Los Angeles • Louisville • Miami • Milwaukee Minneapolis • Muncie • New Orleans New York • S. Pasadena • Philadelphia Pittsburgh • Portland, Ore. • St. Louis Seattle • San Francisco • Syracuse Montreal • Toronto • Vancouver

Circle 468 on page 19

Here's the inside story—



Cutaway view of All-Motor type Motoreducer, connected by Falk Steelflex Coupling to standard NEMA frame motor

WHY Falk Motoreducers give better service—have longer life

Here is the "inside story" behind the all-steel All-Motor type FALK Motoreducer's universal reputation as a gear drive unmatched in quality, efficiency, dependability, ease of maintenance and long life. These "In-built" factors are—

1 **ALL-STEEL HOUSINGS.** Rugged, strong, rigid...all parts are manufactured from heavy steel plate, formed and welded in the Falk Weld Shop.

2 **LARGE OVERHUNG LOAD CAPACITY.** Large shafts, oversize bearings...rigid mountings with wide bearing spans to handle maximum applied loads.

3 **PRECISION GEARING.** Heat-treated alloy steel gearing, precision cut and shaved after heat treatment to eliminate distortion. Quiet, crown-shaved pinions.

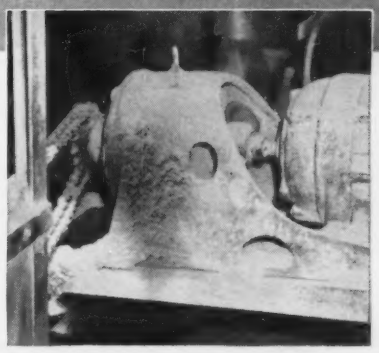
4 **EXTRA-CAPACITY GEARING.** Special extra-capacity gear-tooth form with larger contact area gives greater strength, higher load-carrying capacity.

5 **SEALED HOUSINGS.** Splashproof, dustproof, oil-tight construction. Dual closures and one-way vents keep oil in, dust and moisture out.

6 **POSITIVE LUBRICATION.** Large sump capacity...oiltight construction assures clean lubricant...revolving elements lubricated by direct dip.

When you buy or specify the All-Motor type FALK Motoreducer, you get all these—plus the tremendous advantage of full interchangeability of motors. Switch motors as desired—use any make, style or type of standard foot-mounted motor within the unit's AGMA rating—with a minimum of difficulty or "down time."

Available in sizes up to 75 hp—*with or without motor*—from convenient factory, field or distributor stocks, from coast to coast. **Write for Bulletin 3100.**



60,000 HOURS WITHOUT A FAILURE!

Sixty thousand hours is a lot of hours—but the FALK Motoreducer in the unretouched photo above has served that long without failure or need of repair.

This 3 hp unit is one of over 60 FALK Motoreducers in daily service in an Eastern plant of a large milling company, whose president says, in part:

"One of the main advantages of FALK Motoreducers is their adaptability to any motor. Reducers and motors can be easily interchanged....Our service records confirm the wisdom of our choice of FALK equipment as our standard."

FALK ...a good name in industry

THE FALK CORPORATION, MILWAUKEE, WISCONSIN

MANUFACTURERS OF

- Motoreducers
- Speed Reducers
- Flexible Couplings
- Shaft Mounted Drives
- High Speed Drives
- Special Gear Drives
- Single Helical Gears
- Herringbone Gears
- Marine Drives
- Steel Castings
- Weldments
- Contract Machining

Circle 469 on page 19

(Advertisement)

New stop clock designed for accuracy, versatility

Today's product designer, control systems engineer, nuclear physicist, and graphic panel manufacturer have a common need—an instrument capable of measuring elapsed time to a hundredth of a second, with an accuracy better than 0.02 of 1%.

Wide field—wide requirements

But there the sameness ends—the nuclear physicist needs a hermetically sealed device for remote control; the product designer requires load switches and local pushbutton reset; the graphic panel man wants smart appearance. The lab technician wants a portable model. The military asks for the smallest unit consistent with reliable readings, while the sports event timekeeper must have a large dial.

How can you meet these diverse requirements? Well, here's the answer to that question—a product of Cramer's experience and knowledge of precision timing.

Accuracy for everybody

You select a small, powerful and inherently accurate drive motor, add a 110-tooth positive clutch and apply it on the high-speed shaft. Back it up with a potent relay. When the signal comes, the unit responds instantly, and we have *accuracy*.

All-electric operation for flexibility

Add heart cams on the mainshaft and a rugged solenoid to belt them home within 1/10 second after the reset switch is operated. Now we have *electrical reset*, either remote or local.

For *versatility*, provide for load switches with cams on fast or slow pointer shafts. Cut and set at the factory, cams will offer a variable number (and duration) of pulses per second or minute, or with load switches wired in series, the unit can be used as a highly precise time delay relay or interval timer.

Commercial or Mil-Spec housings

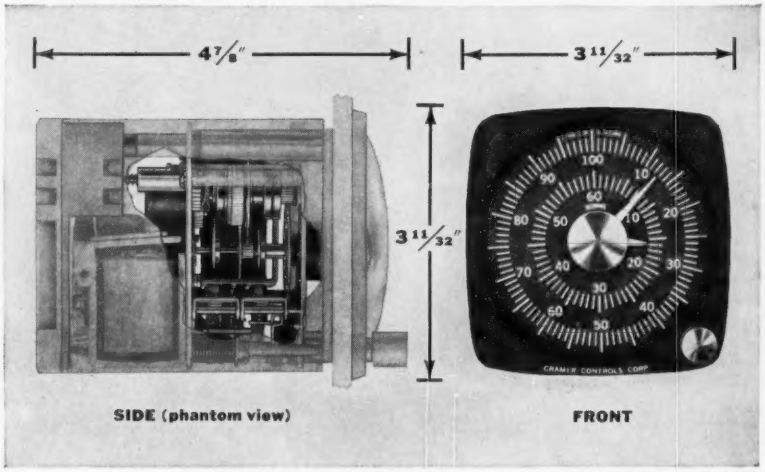
Now let's enclose the mechanism. Commercial housing is dust-tight and has a 12-place terminal block. Also developed: a militarized model to withstand high vibration, shock and severe environments. A deep-drawn solder-sealed enclosure with 14-pin glass-beaded header, evacuated and hermetically sealed will do it.

Dials, pointers—Loewy styled

What's left? The business end of things —dial and pointers. Let's tackle this for readability, and at the same time, shoot for eye-appeal. This time we'll go to the *styling* experts — famous industrial designers, Raymond Loewy Associates. They come up with the last word in human-engineered dial-pointer combination for fast, exact readings. Frame it with a pleasing bezel that can be finished to match or harmonize with your panels.

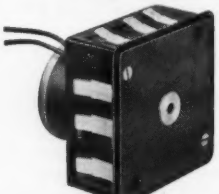
Now it looks like the precise instrument that it is—the new Cramer Type 691 Time Totalizer. Bulletin PB-691 tells more about it. Write for your copy today. The Cramer Controls Corp., Box 6, Centerbrook, Conn.

P.S. We've got the six-inch dial version and the portable model, too. 7.20

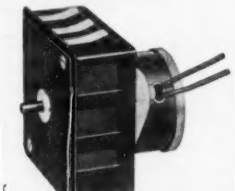


NEW time totalizer. Type 691 features instantaneous electrical reset, accuracy within 0.02 of 1%. Standard ranges: 60 seconds in 1/100 sec., 60 minutes in 1/100 min., and 60 minutes in seconds. Factory-set cam-operated load switches (rated at 5A, 250 vac, resistive) can be supplied. Available for standard voltages at 50, 60 cps; for 400 cps with d-c clutch; and for d-c voltages. Mechanical and electrical life in excess of 1-million operations.

TWO MORE NEW CRAMER PRODUCTS



NEW cycling timer. Type 571, ideal for "cycling" electrical equipment such as appliances, vending machines, advertising displays, at lowest possible cost. 1 to 4 poles. Speeds from 1 rpm to 1 revolution in 8 days with 30-amp contacts. Faster speeds with lighter contacts on special order.

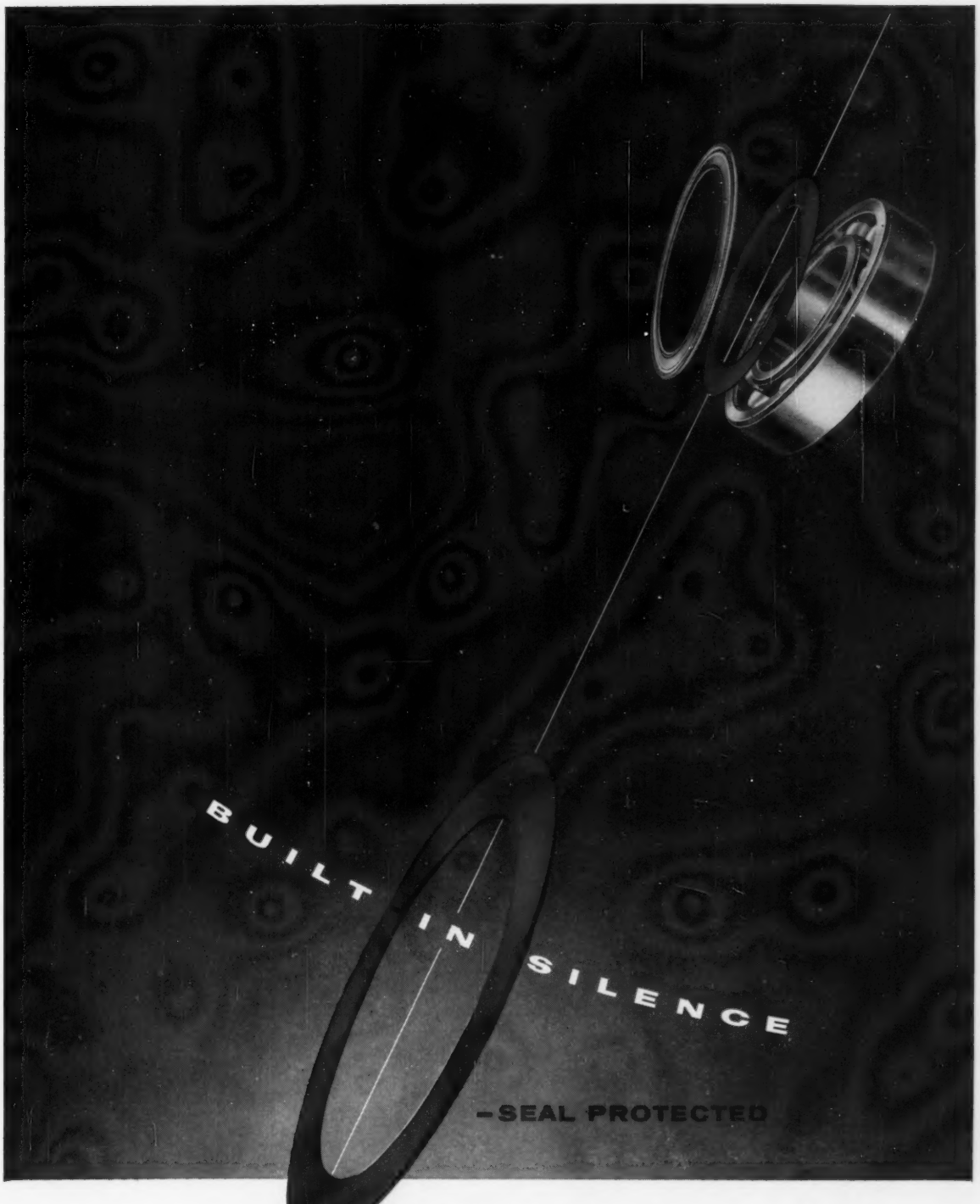


NEW interval timer. Type 271, for built-in applications. Provides an economical way of timing appliances, photo equipment, ovens, etc., for manually preset interval. 1 or 2 poles. Time ranges from 45 seconds to 6 days with 30-amp contacts. Normally furnished without knob or dial.

TALK IT OVER WITH

CRAMER CONTROLS
CORPORATION

Circle 470 on page 19



EVERY TYPE—EVERY USE

SKF®

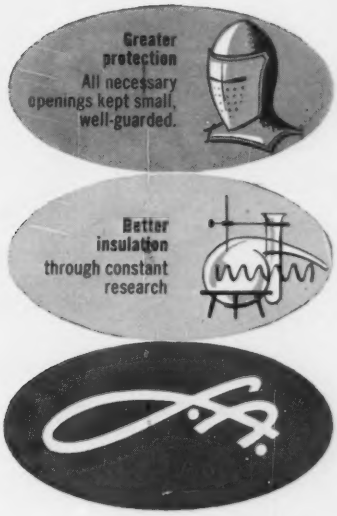
- *Ball Bearings*
- *Cylindrical Roller Bearings*
- *Spherical Roller Bearings*
- *Tapered Roller Bearings* ("Tyson")

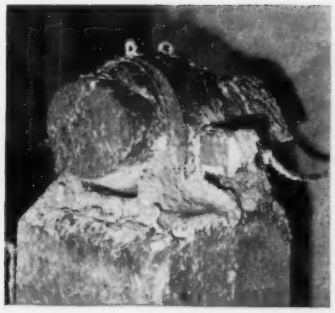
7762

® Reg. U.S. Pat. Off. Tyson Bearing Corporation

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.

The most silent rolling contact bearing in the world of today





Be glad you weren't working here...

But this sturdy Louis Allis motor was, and still is!

Shortly before this picture was taken, that pulp-mill pump suddenly ruptured. Blasted every object in the area with a thick coating of hot paper pulp.

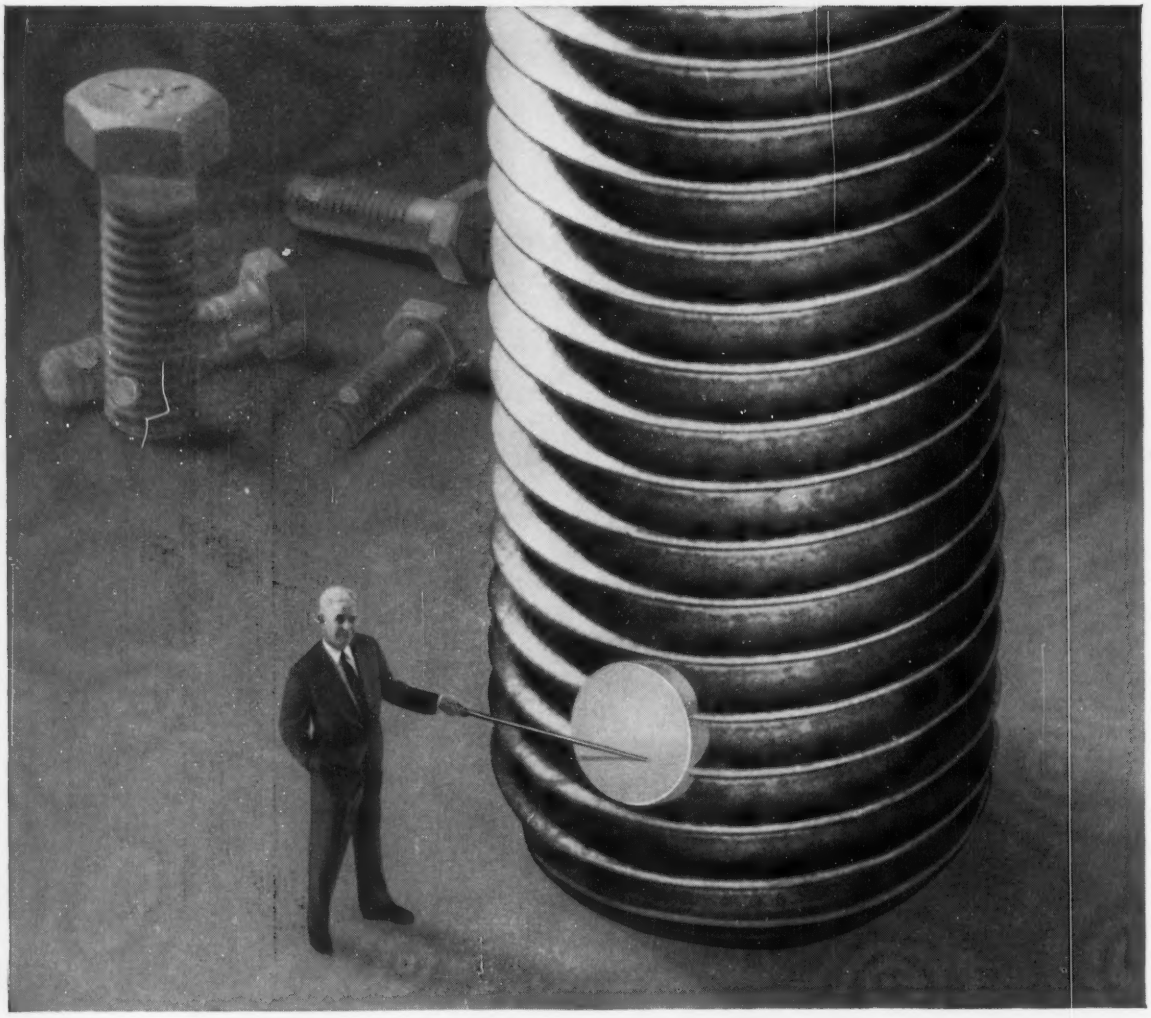
But note the Louis Allis 20 HP splash-proof motor designed to take this kind of abuse — and come back for more! Note that it took the full force of this blast on its vented *underside* — a motor's most vulnerable point. Only a sturdy, well-designed motor could resist this. Still functioning perfectly this one didn't miss a beat!

Let us tell you more about Louis Allis electric motors. About such unique features as the new varnish of Gilsonite combined with phenolics and alkyds that provides the highest degree of moisture, acid, and alkali resistance . . . locked bearings that reduce end play and extend bearing life . . . the dynamically balanced rotor. And about the many other Louis Allis extras better discussed at length in our file-sized Reference Bulletin 1700. Why not write for it today? The Louis Allis Co., 459 East Stewart Street, Milwaukee 1, Wisconsin.

LOUIS ALLIS

MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

Circle 472 on page 19



Cleveland Nylok self-locking hexagon head cap screws hold tight, speed production, simplify design

NOW STOCKED IN ALL STANDARD SIZES FROM ¼ TO 1 INCH

A Cleveland Nylok* hexagon head cap screw is self-locking — won't work loose. The locking device is a tough, resilient pellet of nylon that forces the mating threads together in a secure metal-to-metal union. All auxiliary locking devices are eliminated. Seated or unseated, the screw locks wherever wrenching stops. And because of "plastic memory," the pellet tends to recover its original shape and the screw can be used repeatedly.

These self-locking cap screws give uniform torque and will not gall or damage threads or seating surfaces. They are not affected by aging or by temperatures from −70° to +250°F. Further, when screws are properly seated, the locking pellet functions as a liquid seal.

You will save on production time when you use Cleveland Nylok self-locking screws. In addition, you can simplify design and reduce size, weight and inventory. Contact your Cleveland distributor for these self-locking screws in all standard sizes from ¼ to 1 in., in high carbon quenched and tempered steel (C-1038).

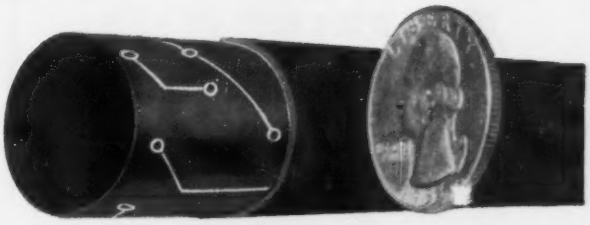
*T.M. Reg. U.S. Pat. Off., The Nylok Corporation

Write today for your copy of the Cleveland Nylok folder giving complete technical data and specifications on self-locking hexagon head cap screws. We can also supply other standard and special screws with the Nylok self-locking feature.

THE CLEVELAND CAP SCREW COMPANY
4444-6 Lee Road, Cleveland 28, Ohio
WAREHOUSES: Chicago • Philadelphia • New York • Los Angeles

Circle 473 on page 19

new Formica® flexible copper clad...



fits larger circuits...into smaller spaces

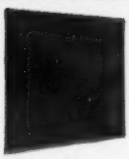
The remarkable new Formica flexible copper clad laminated plastics save space like never before. Notice how a 40 square inch flat circuit above is contained in a space only 10 cubic inches!

Works fine, too. There's no shorting because of the insulation the flexible sheet provides.

Flexible copper clad offers the product designer circuits in new shapes . . . plus increased miniaturization. For example, as shown above, an .008" sheet can be confined in a ¾" diameter tube.

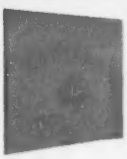
For complete information on the design improvement possibilities Formica flexible copper clad holds for your products—civilian or military—write for new FF 89 data sheet. Formica Corporation, subsidiary of American Cyanamid, 4514-7 Spring Grove Ave., Cincinnati 32, Ohio.

FI 1417



high IR, cold punching copper clad

XXXP-36 for finest printed circuitry. Offers 1,000,000 megohms insulation resistance, cold punches to and including 1/16". It's the original translucent, watermarked sheet so widely copied but never duplicated.



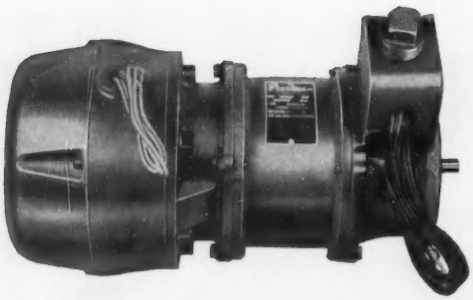
new glass epoxy high temperature copper clad

FF 91-1 — retains mechanical strength and insulating properties at high temperatures and humidity. Cold punching and chemical resistant. Ideal for rockets and missiles.

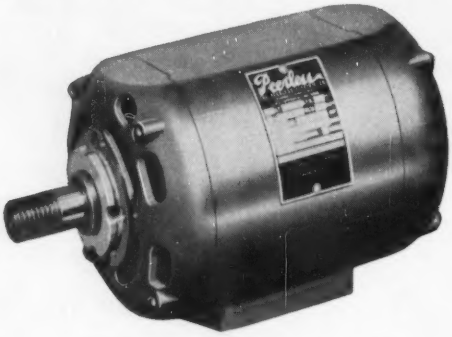
Save your engineers — use Formica-4 the complete laminated plastics service

1. Application engineering 2. Research
3. Fabricating 4. Customer stock service

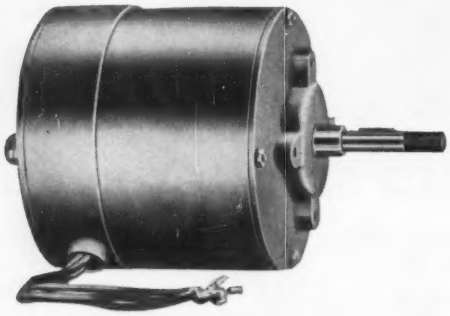
Circle 474 on page 19



EXPLOSION-PROOF TORQUE MOTOR WITH BRAKE



COMPACT DESIGN RADIAL SAW MOTOR



NAVY MOTOR—SPRAY-TIGHT

SPECIAL MOUNTED VERTICAL MOTOR

If stock motors cut machine efficiency see Peerless.

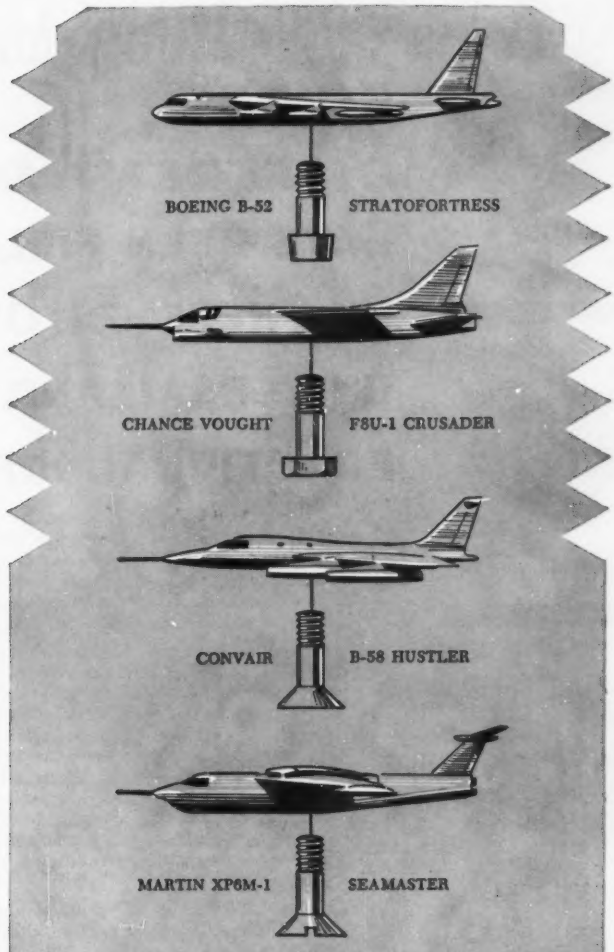
Peerless builds a complete line of general purpose motors as well as hundreds of specials designed to meet specific needs. Our engineers have wide experience in applications of all types, and specialize in solving motor problems for design engineers who require unusual mountings or unusual construction to achieve maximum machine efficiency. Consult your nearby Peerless representative or write directly to us about any motor problem. We'll work with you to develop the one motor that powers your equipment best. Write for Bulletin SDA-155 now.

Single phase
½ thru 7½ HP

Polyphase
½ thru 30 HP

ELECTRIC MOTOR DIVISION
THE *Peerless-Electric*® COMPANY
FANS • BLOWERS • MOTORS • ELECTRONIC EQUIPMENT
1520 W. MARKET ST • WARREN, OHIO

Circle 475 on page 19



BASED ON STRENGTH

VOI-SHAN TITANIUM FASTENERS OF GUARANTEED STRENGTH are backed by the thousands of man-hours and dollars that must be invested to develop the skill and the precise conditions necessary to manufacture a titanium bolt, screw, or rivet of the superior requirements for the jet age. Our bid for peace is firmly based on the strength of our air force. Voi-Shan Titanium Fasteners lend strength to many of our present day aircraft, including the B-52, F8U-1, B-58, and XP6M-1.

Send your inquiries to

THE LEADER IN AIRCRAFT FASTENERS

VOI-SHAN

MANUFACTURING COMPANY

A division of PHEOLL MANUFACTURING COMPANY

8463 Higuera St., Culver City, California

Offices in principal cities of the United States and Canada

Circle 476 on page 19

MORE THAN *50,000 DIFFERENT SPECS* HAVE BEEN FILLED BY THESE 6 HOWARD UNIVERSAL AND D.C. FRACTIONAL H.P. MOTORS

These 6 Howard motors account for over 50,000 specifications, both military and commercial. One reason for this wide use is Howard's ability to produce variations *exactly* suited to specific needs.

Howard motors have such field-proven engineering features as automatic slot cell insertion, which practically eliminates "grounds;" Zanderoll processed double dipped and double baked armatures providing deep, uniform varnish penetration for high bond strength and rock-hard coils minimizing "shorts and opens;" improved brushholder construction for accurate alignment and longer life; 2-stage, 3-plane dynamic balancing; and automatic winding for tough compact coils, giving uniform performance.

If you are currently using universal and D.C. motors from 1/200th to ½ H.P., check with Howard today.

GEAR REDUCTION UNITS

Model	Ratio	
	min.	max.
11A	3:1	2700:1
Imperial	3:1	2700:1
100	3:1	2700:1
512	3:1	2700:1
700	21.5:1	2600:1
1100	3:1	2700:1

ELECTRICAL SPECIFICATIONS

	MODEL 11A				MODEL 100				MODEL 512			
	SERIES MOTOR	SHUNT MOTOR	SERIES MOTOR	SHUNT MOTOR	SERIES MOTOR	SHUNT MOTOR	SERIES MOTOR	SHUNT MOTOR	SERIES MOTOR	SHUNT MOTOR	SERIES MOTOR	SHUNT MOTOR
NO LOAD SPEED (RPM)	15M	3.5-10M	18M	2-10M			@ 15M	3.5-10M	15M	2-9M	18M	9M
FULL LOAD SPEED (RPM)	5-10M	3-8M	5-10M	1.5-8M	5-10M	1.8-6M	5-10M	3-8M	5-10M	1.8-6M	5-10M	1.8-6M
MAX. H.P. CONT. @ MAX. R.P.M.	1/75 No Fan	1/75 No Fan	1/15	1/20	1/50	1/50	1/50	1/50	1/10	1/12	1/4	1/8
MAX. H.P. INTER. @ MAX. R.P.M.	1/20	1/20	1/8	1/10	1/13	1/13	1/15	1/15	1/5	1/6	1/2	1/4
FULL LOAD AMPS. CONT. @ 115V.	.4	.4	1.1	1.1	.35	1.6 at 24V	.8	.45	1.5	1.5	4	1.7
FULL LOAD AMPS. INTER. @ 115V.	.75	.75	2.0	2.0	1.0	5 at 24V	.70	.90	3.0	3.0	7.6	3.0
% EFF. AT FULL LOAD CONT.	30	30	35	30	35	35	40	35	50	45	50	50
% EFF. AT FULL LOAD INTER.	35	35	50	45	45	45	45	45	60	55	65	55
VOLTAGE	12-115	6-120	6-115	6-120	12-120	6-32	12-230	6-120	24-230	12-230	24-115	12-230
ROTATION	CW, CCW, REV.	CW, CCW, REV.	CW, CCW, REV.	CW, CCW, REV.	CW, CCW, REV.	CW, CCW, REV.	CW, CCW, REV.	CW, CCW, REV.	CW, CCW, REV.	CW, CCW, REV.	CW, CCW, REV.	CW, CCW, REV.

Maximum H.P. ratings are shown. Variations are available for less power to meet application requirements.

Other Howard motors: UNIVERSAL & D.C. 1/200 to 1/2 h.p. • SHADED POLE 1/2000 to 1/8 h.p. INDUCTION 1/1400 to 1/8 h.p. • SERVO MOTORS • GEAR MOTORS • BLOWERS

HOWARD

HOWARD INDUSTRIES, INC., 1735 STATE ST., RACINE, WIS., TELETYPE: RAC 344

Sales Offices 208 S. La Salle St., Chicago 4 · 942 S. La Brea Ave., Los Angeles 36 · Room 4822, Empire State Bldg., New York 1 · 300 Broadway, Camden, New Jersey

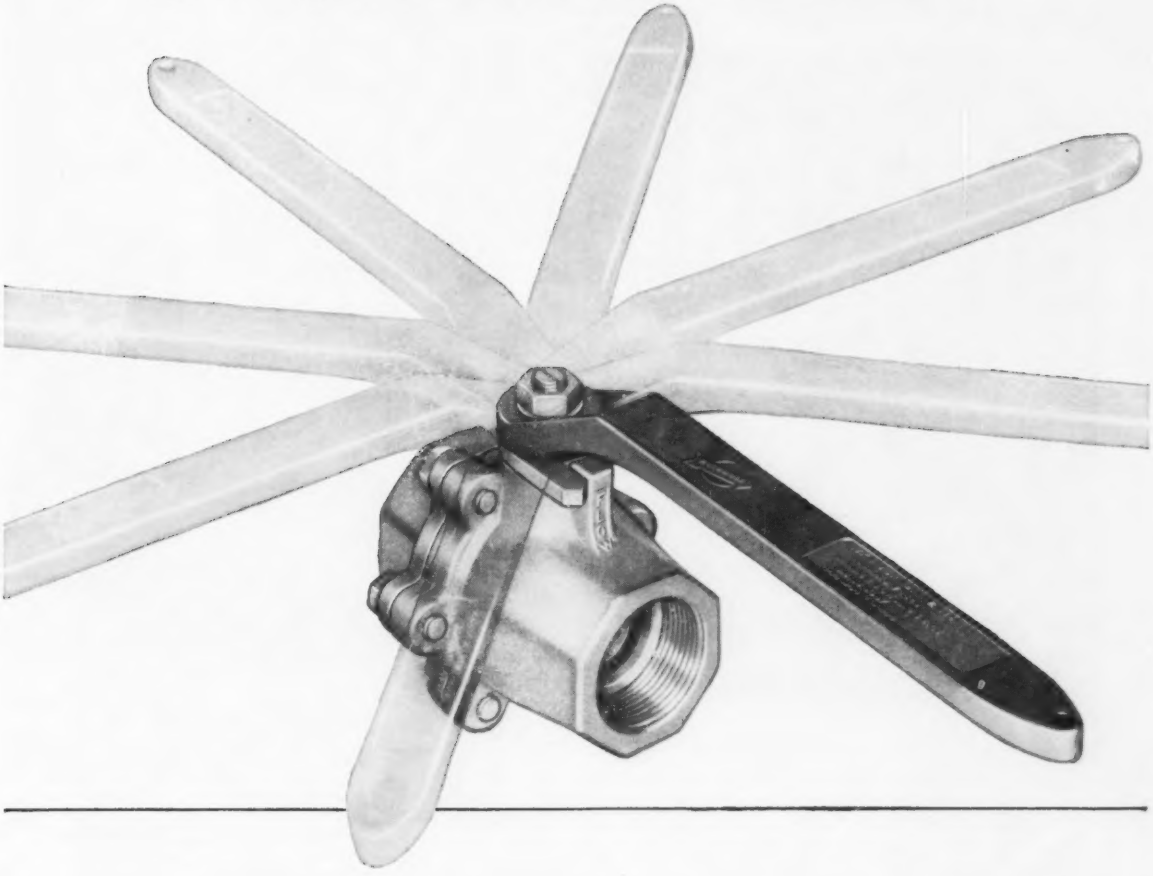
Buy Defense Bonds

DIVISIONS: EMC ELECTRIC MOTOR CORPORATION · CYCLOHM MOTOR CORPORATION · RACINE ELECTRIC PRODUCTS

Circle 477 on page 19

New Rockwood Forged Ball Valves

8 Ways Easier to Handle!



New Rockwood Ball Valves are made of forged brass for greater tensile strength and safety. You're assured of Full, Round Flow and fast, efficient operation and less friction loss too.

The handle of the new Rockwood Forged Ball Valve can be positioned in 8 different ways *giving you greater convenience.* The ¼ turn opens and closes the valve — *giving you Full, Round Flow, efficient operation, less friction.* The pressure of fluid in the Rockwood Forged Ball Valve automatically positions the ball against the synthetic rubber seat — *giving you a leakproof seal.* The forged brass ball in the Rockwood Forged Valve is chrome-plated to stand up under abrasion, pitting, scratching — *giving you trouble-free service.*

The new Rockwood Forged Ball Valve comes in pipe sizes from ⅜" to 2". Tested and listed by Underwriters' Laboratories, Inc. Mail the coupon now for complete specifications and information.

ROCKWOOD BALL VALVES

FULL, ROUND FLOW

ROCKWOOD

ROCKWOOD SPRINKLER COMPANY
2164 Harlow Street
Worcester 5, Mass.

Send me illustrated folder on Rockwood Full, Round Flow Ball Valves.

Name.....

Title.....

Company.....

Street.....

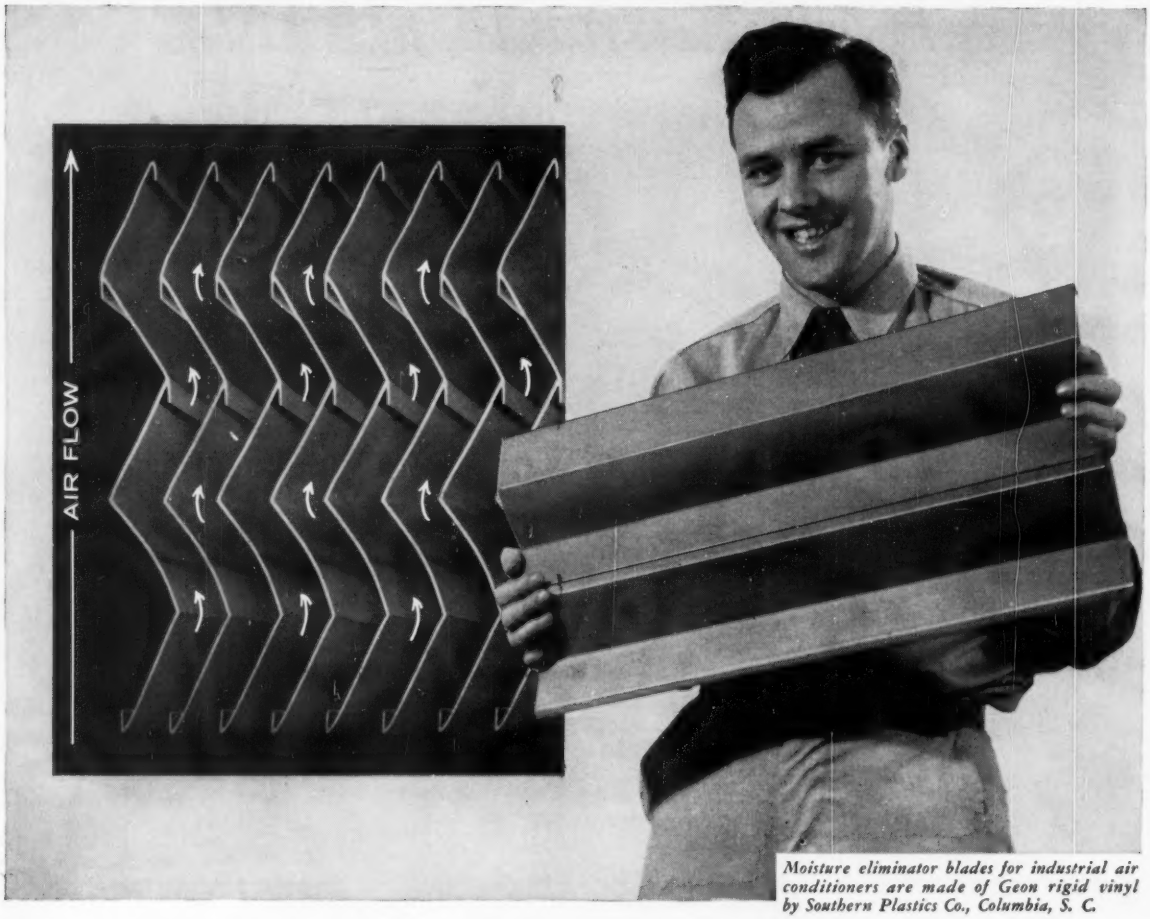
City.....

Zone....State.....

Circle 478 on page 19

Another new development using

B.F.Goodrich Chemical *raw materials*



Moisture eliminator blades for industrial air conditioners are made of Geon rigid vinyl by Southern Plastics Co., Columbia, S. C.

blades of Geon keep air dry...end replacement problems

THESE moisture eliminator blades for industrial air conditioners are now made of Geon rigid polyvinyl chloride compound — to end frequent replacement of formed sheet metal blades.

Parts made of Geon rigid vinyl won't corrode. They are economical, easy to clean and extremely durable... meet flameproof requirements. Air-carried corrosive materials have no destructive effects on these blades because Geon has exceptional resistance to acids, alkalies and other chemicals.

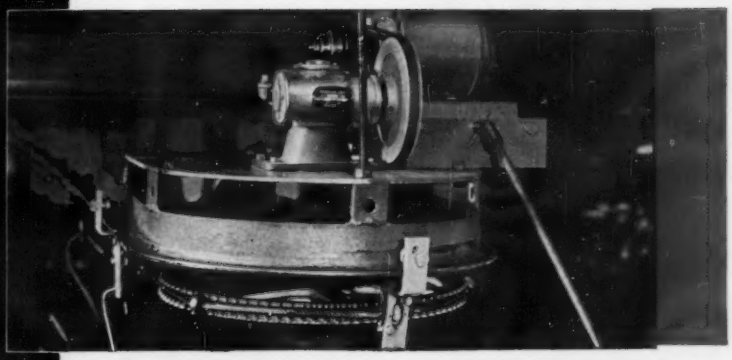
Geon polyvinyl resins and plastics are unique raw materials. Their outstanding physical, chemical and electrical properties have opened markets for many new products—rigid piping, wire insulation, flexible wall covering, foam padding, coatings for textiles, metal and paper.

For further information on Geon write Dept. GA-5, B.F.Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

B.F.Goodrich Chemical Company
a division of The B.F.Goodrich Company

B.F.Goodrich GEON polyvinyl materials • HYCAR American rubber and latex • GOOD-RITE chemicals and plasticizers • HARMON colors

smaller....
lighter....
Fractional Horsepower Speed Reducers

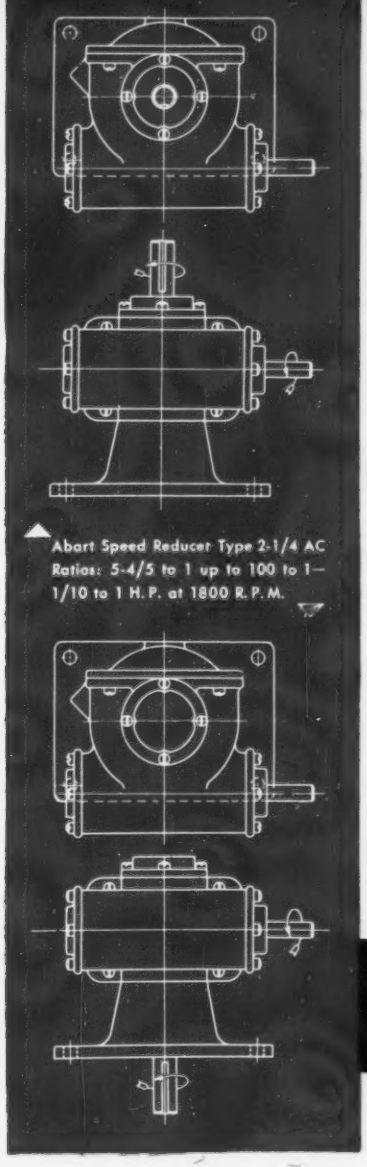


solve problems for the design engineer

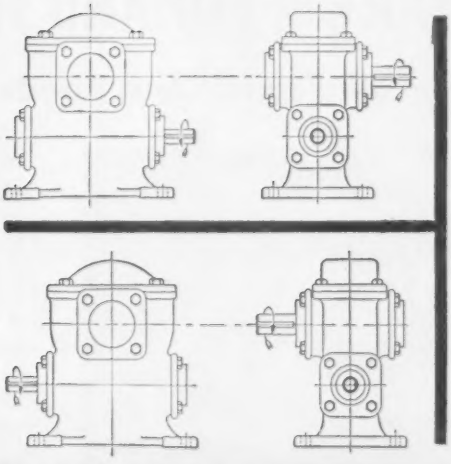
Where do you need the output shaft—Right? Left? Up? Down? Shafts in line? Shafts parallel but offset? Want a high ratio reduction with right angle take-off? Space limited?

Whatever factor of selection—ratio, space, shaft position, shock load, application—all the answers are found in the latest Abart Speed Reducer Engineering Data Book and Catalog.

Write for your copy today



Abart Speed Reducer Type 2-1/4 AC
Ratios: 5-4/5 to 1 up to 100 to 1—
1/10 to 1 H.P. at 1800 R.P.M.



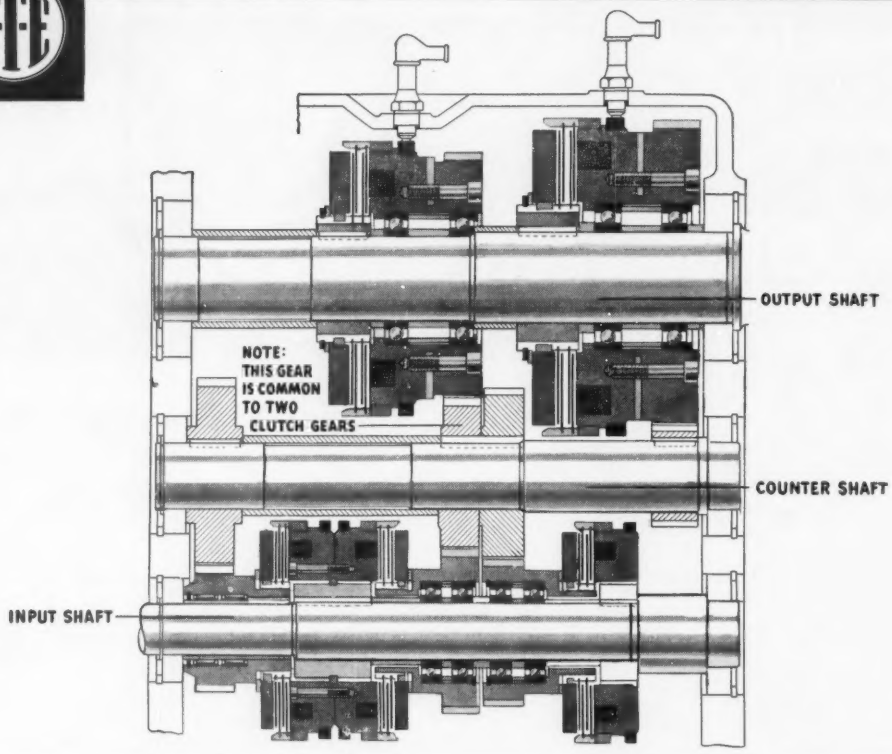
Abart Speed Reducer
Type 2-5/8 AB
Ratios: 5-4/5 to 1
up to 100 to 1—
1/6 to 2 H.P.
at 1800 R.P.M.

Abart GEAR & MACHINE CO.

4821 WEST 16th STREET
CHICAGO 50, ILLINOIS

Circle 480 on page 19

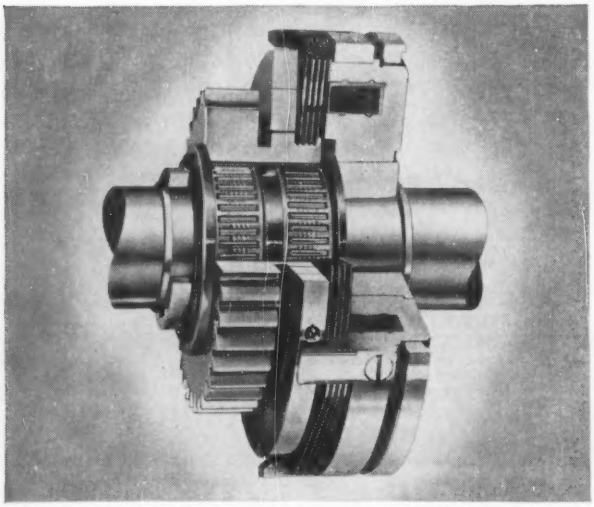
ELECTRO CLUTCHES



A typical 6-speed transmission box. This transmission uses three single and one double Electro Clutch. The lower shaft is the input shaft, and three clutches (one single and one double) are mounted on this shaft. The three free-running gears of the three clutches mesh with three gears on the countershaft. The countershaft can now be given any one of three different speeds, depending on which of the three clutches is engaged. The output shaft, on top, is equipped with two single clutches, the free running gears of which mesh with two fixed gears on the countershaft. The output shaft can now be given two different speeds to any one of the three countershaft speeds, or a total of six different speeds.

INSTANT SPEED AND FEED CHANGES

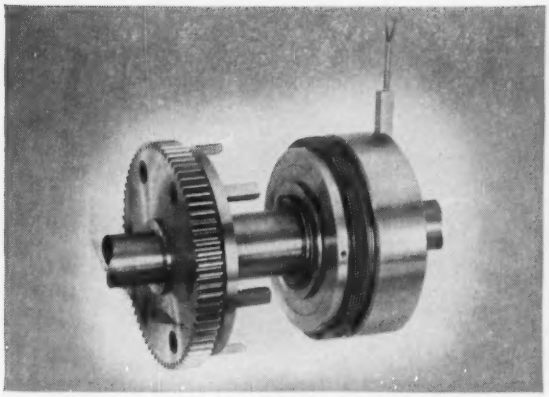
Operates under oily conditions, needs no adjustment or upkeep



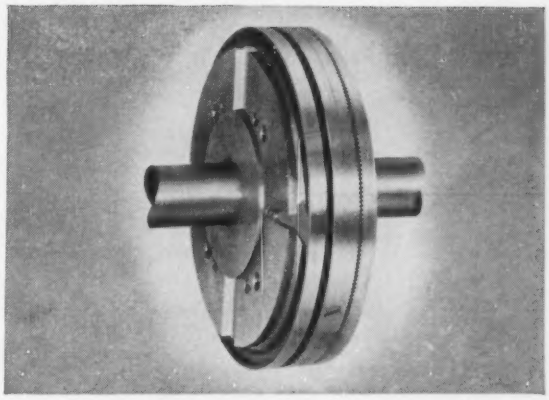
Type H—Internal drive, showing unit construction.

Step up machine tool productivity. I-T-E Electro Clutches permit instant speed or feed changes without stopping the machine or manually changing gears, chains, cams or belts. Any of a variety of actuating devices—push buttons, limit switches, relays—may be used. A simplified, completely electric control system directly actuates the Electro Clutch without any intermediate auxiliary devices. No mechanical connections required.

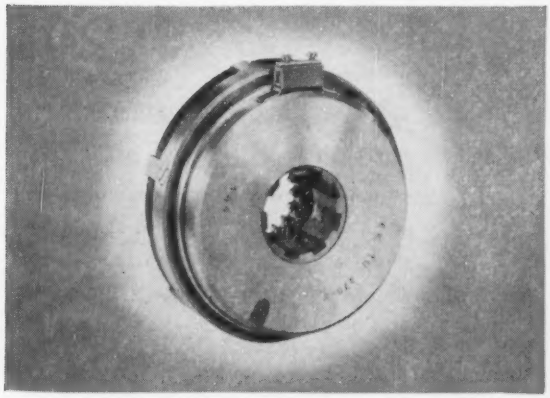
I-T-E Electro Clutches are being used by a growing number of prominent machine tool manufacturers. They're available in torque ratings from 3.2 lb. ft. to 13,000 lb. ft. Diameters from 2.36 in. to 15.75 in., with corresponding lengths from 0.810 in. to 4.75 in. for the complete clutch. For detailed information, write I-T-E Circuit Breaker Company, Transformer & Rectifier Division, 19th & Hamilton Sts., Phila. 30, Pa.



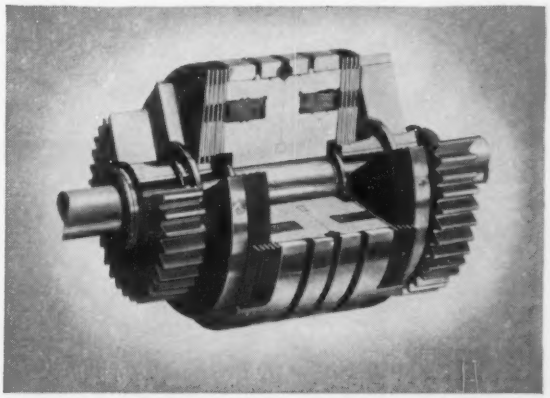
Type R—Stationary field design, showing unit construction.



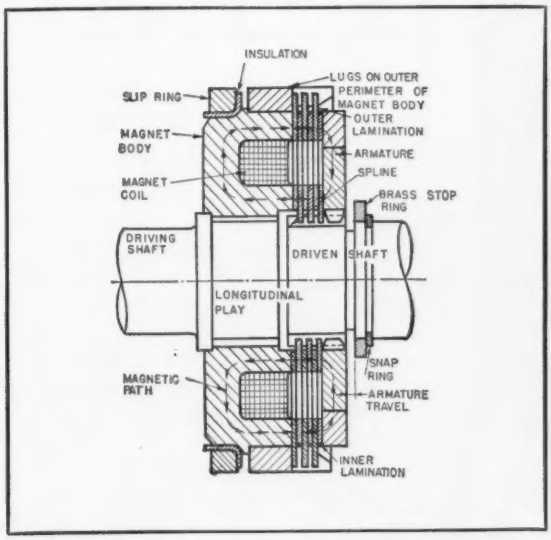
Type F—Serrated face tooth design. High torque, small size.



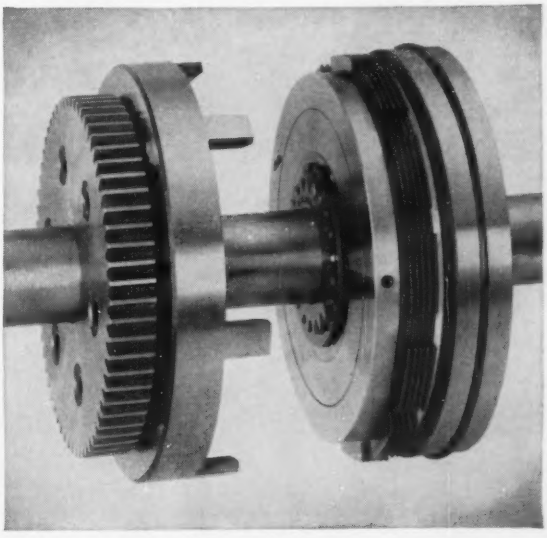
Single clutch equipped on a brake. No slip ring is supplied, but terminal is provided for the coil and user's connections.



Standard double—Gear drive with double Electro Clutch, showing unit construction.



Principle of operation. Alternate laminations key with perimeter lugs and splined shaft respectively. Laminations rotate freely until magnet coil is energized. Magnetic flux compresses the laminations with great force, engaging clutch.

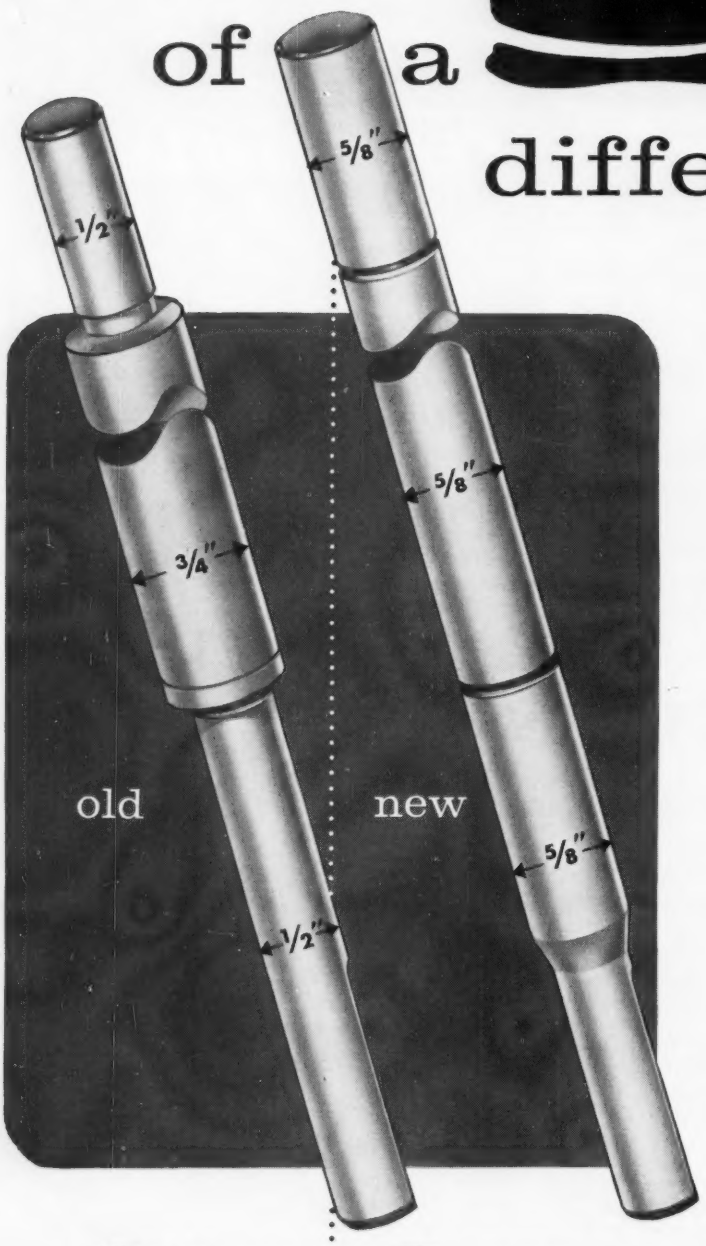


Type C—External drive, showing unit construction.

I-T-E CIRCUIT BREAKER COMPANY • **Transformer and Rectifier Division**

Circle 481 on page 19

1/8-INCH made a whale of a difference



Designed for you...the motor buyer... an entirely new motor shaft, that assures longer life, more dependable motor power for your laundry equipment product.

This new 5/8" shaft reduces bearing wear...provides rapid heat dissipation...greater load-carrying capacity...lower average noise level...reduced end play, and practically stops end-play "growth".

Just another reason to always specify Emerson-Electric Custom-Engineered motors! WRITE TODAY for complete details...
Dept. M-73
The Emerson Electric Mfg. Co.,
St. Louis 21, Mo.

Shaft (left) is now being replaced by new-design 5/8" shaft (right) in all Emerson-Electric Motors for laundry equipment.

EMERSON-ELECTRIC of St. Louis

LIVE BETTER ELECTRICALLY

since 1890

Circle 482 on page 19

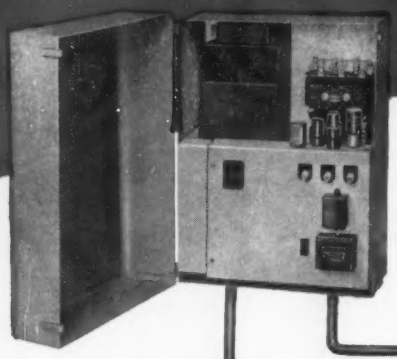
Ideas for new or better products are easy and economical to carry out when they call for aluminum extrusions. You can rely on shapes supplied by Revere because all of our experience and skill are devoted solely to the service of our metal customers. It will pay you to tie the growth of your business to the most dependable sources of supply. Revere Copper and Brass Incorporated. Founded by Paul Revere in 1801. Executive Offices: 230 Park Avenue, New York 17, N. Y.

Revere Aluminum Mill Products include coiled and flat sheet, both plain and embossed, circles, blanks, Tube-In-Strip, extruded products, seamless drawn tube, welded tube, rolled shapes, electrical conductors, forgings, foil, and frozen food containers.

Circle 483 on page 19

DYNAMATIC®

Drive Package Provides Infinitely Adjustable Speeds from AC Power Source



CONTROL PANEL

CONTROL STATION

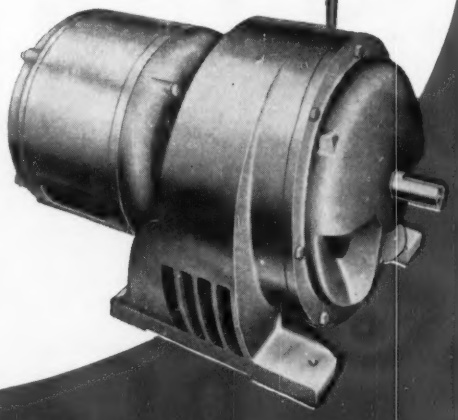
The complete Dynamatic power package includes all components required to provide infinitely adjustable speeds from an alternating current power source. A Dynamatic Ajusto-Spede® or Dynaspede® Drive, with electronic control and pushbutton station, satisfies the requirements of almost any application where proper machine operation or material processing depends upon control of operating speeds.

The compact control panel may be remotely mounted to conserve valuable space on the driven machine. The pushbutton station at the operator's position puts vital controls conveniently at the operator's fingertips and requires a minimum of space.

Speeds are infinitely adjustable from 0 RPM to full output speed, and accurate speed regulation may be obtained from 100 RPM to full output speed.

Ajusto-Spede® Drives, available in ratings of 1/4 horsepower to 75 horsepower, are air-cooled. Dynaspede® Drives, rated from 3 to 75 horsepower, are liquid-cooled. Raise your productive efficiency with Dynamatic eddy-current units.

DYNAMATIC®
AJUSTO-SPEDE DRIVE

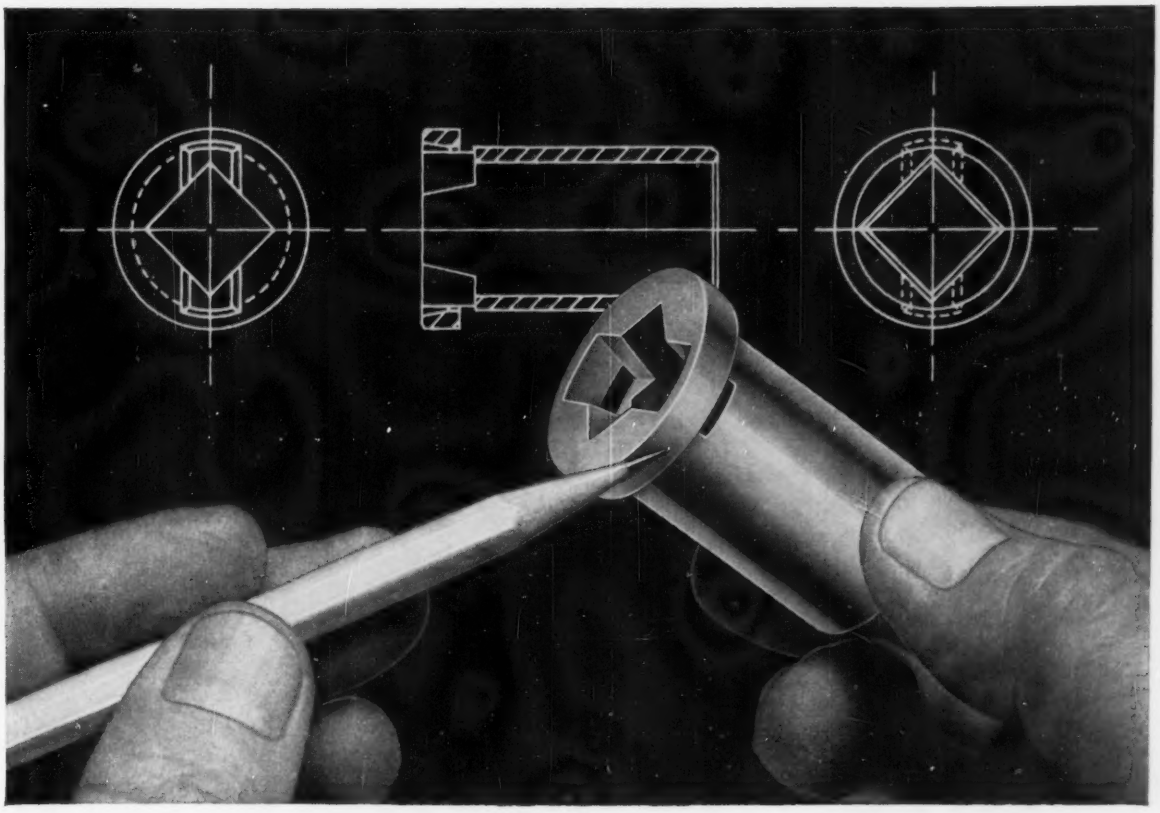


Send for Illustrated Literature Describing Dynamatic Adjustable Speed Drives

EATON

DYNAMATIC DIVISION
MANUFACTURING COMPANY
3307 FOURTEENTH AVENUE • KENOSHA, WISCONSIN

Circle 484 on page 19



How Would YOU Produce This Part With No Machining . . . No Scrap Metal?

PARKER SALES ENGINEERS

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Can't be done? Parker did it . . . sharp internal corners, lateral holes, chamfers, flanged end and all . . . by fast, low-cost powdered metal pressing and sintering. No subsequent machining . . . no scrap-metal loss. Just think of the savings compared with conventional machining methods.

In addition to these inherent cost savings, Parker-engineered Powdered Metal Parts offer a wide choice of tensiles, ductility, density, impact resistance and other physicals. Tooling-up is done quickly and at relatively low cost.

It will pay you to check on the economies and design possibilities of Parker-engineered Powdered Metal Parts. Just call the nearest sales engineer listed here or write the factory direct.

Parker White Metal Company • 2153 McKinley Ave., Erie, Pennsylvania

PARKER

high pressure ALUMINUM and ZINC die castings
POWDERED METAL PARTS

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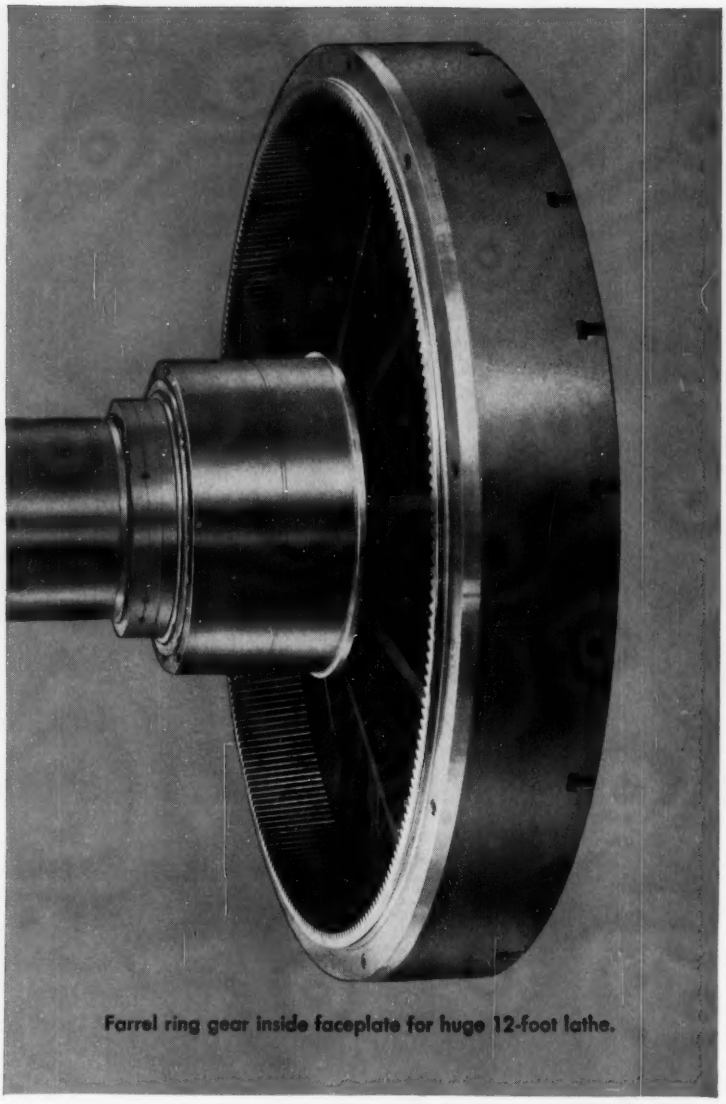
LARGE RING GEARS



Farrel ring gear inside faceplate for huge 12-foot lathe.

designed and built to your requirements

At Farrel, quality gears come in large packages. One example is the single-helical internal gear shown here in a 12-foot diameter, lathe faceplate. Designed to assure a smooth, vibration-free drive at relatively high speeds for the heavy work handled, the gear was precision-generated by the Farrel-Sykes method—a process that assures extreme accuracy of tooth spacing.

Farrel precision-generated internal gears are available with either single helical or spur teeth in sizes up to 23 feet blank diameter.

Farrel also makes external gears of the continuous-tooth herringbone, single-helical and spur types, in any size up to 23 feet diameter, for any power capacity or application.

Whatever your gear requirements may be, you can depend on Farrel's many years of gear engineering and manufacturing experience and complete production facilities.

FARREL-BIRMINGHAM COMPANY, INC.

ANSONIA, CONN.

Plants: Ansonia and Derby, Conn., Buffalo and Rochester, N. Y.
Sales Offices: Ansonia, Buffalo, Boston, Akron, Ann Arbor (Mich.), Chicago, Minneapolis, Fayetteville (N. C.), Los Angeles, Salt Lake City, Tulsa, Houston
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Farrel-Birmingham ®

FB-1124

Circle 486 on page 19

Navy A3D, largest carrier based jet aircraft

The hook's made of Hy-Tuf

designed to take exactly this kind of beating

In a split second, an arresting hook made of Crucible Hy-Tuf® stops a jet dead in its tracks. No other alloy can meet this particular aircraft's needs so well. And Hy-Tuf does it because it was developed by Crucible specifically for aircraft landing gear, hooks, and other such tough applications. Hy-Tuf is covered by AMS-6418B and MILS-7108.

Now other fields are benefiting from Hy-Tuf's tensile strength of over 230,000 psi. By taking advantage of its high strength and high toughness, cross section can be reduced to save weight. This means savings on a variety of applications from heavy-earth-moving equipment to power tools . . . power-driven garden tools . . . and all types of portable motors where a high strength-weight ratio is important.

Furthermore, special *tools* and *shafts* are logical applications for Hy-Tuf when weight and cross-sectional dimensions must be limited. Where such limitations do not permit sufficient fillet or radius for standard alloys, a higher impact and less notch sensitive alloy, such as Hy-Tuf, is needed.

Ask for data about Hy-Tuf or other ultra high strength steels which may meet your needs more closely.

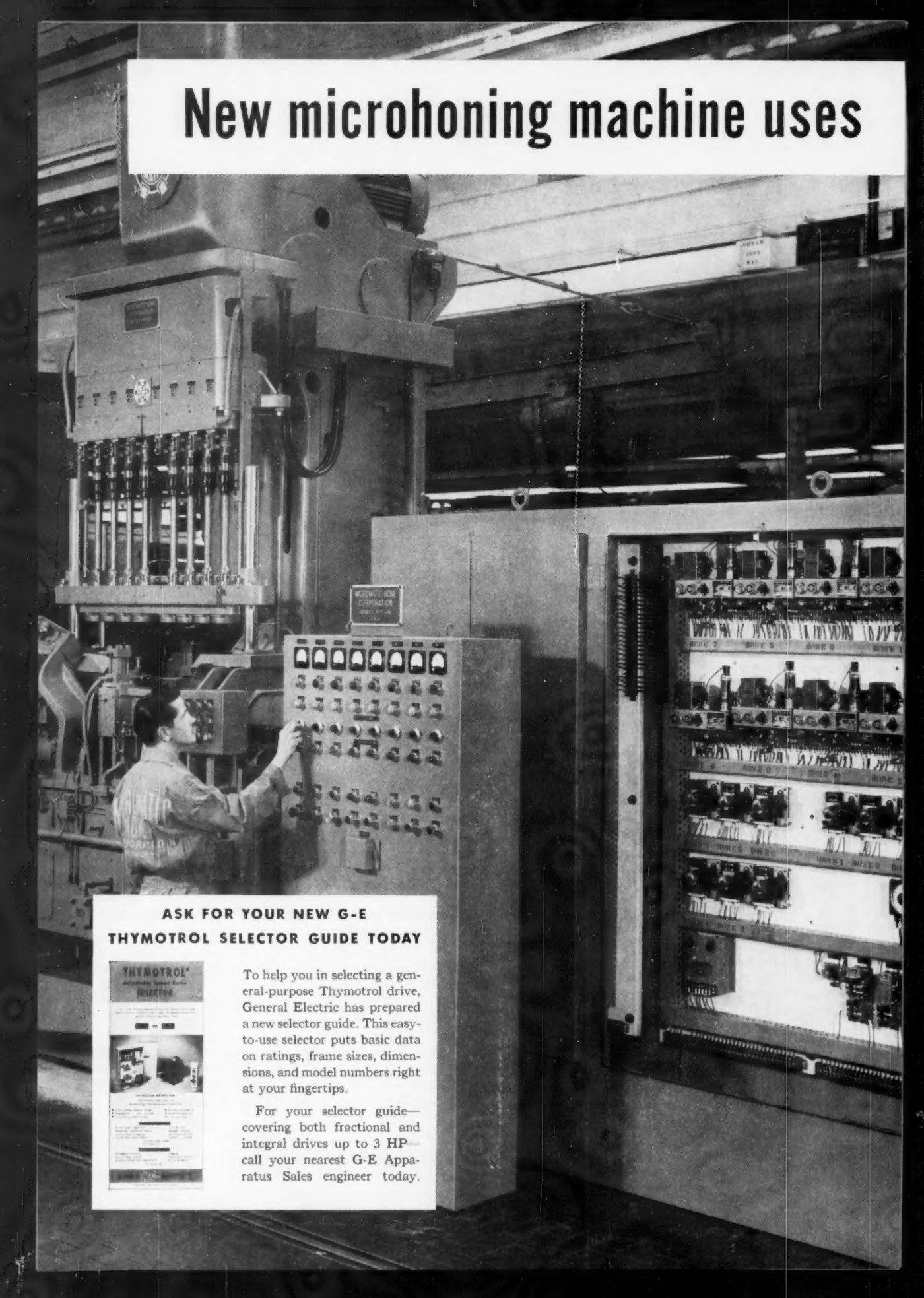
Write to Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

Circle 487 on page 19

New microhoning machine uses



ASK FOR YOUR NEW G-E THYMOTROL SELECTOR GUIDE TODAY

To help you in selecting a general-purpose Thymotrol drive, General Electric has prepared a new selector guide. This easy-to-use selector puts basic data on ratings, frame sizes, dimensions, and model numbers right at your fingertips.

For your selector guide—covering both fractional and integral drives up to 3 HP—call your nearest G-E Apparatus Sales engineer today.

General Electric Thymotrol* drives to speed cutting, boost accuracy

Eight General Electric general-purpose Thymotrol drives—costing up to $248† *less* than other electronic adjustable-speed drives—are precisely controlling the expansion motions of Micromold tools on Micromatic's new machine.

Micromatic Hone Corporation formerly used only hydraulic control in this operation. Now, with G-E Thymotrol drives, they are able to utilize a new type of tool resulting in greater accuracy, improved cutting action, and easier remote operation—*all* at low initial investment.

This is but one of the wide range of G-E general-purpose Thymotrol applications. Today, these job-tailored drives are being used on transfer machinery, machine tools, process pumps, testing equipment—in fact—they are being applied to almost any machine whose performance can be improved with adjustable speed.

OUTSTANDING BENEFITS

Backed by years of leadership in the design, manufacture, and application of adjustable-speed drives, General Electric Thymotrol drives offer:

Increased production—right speed provided for every requirement.

Increased machine versatility—wide speed range and close speed regulation permit use of same machine on a variety of work.

Reduced downtime, lower maintenance—design features such as swing-out panels, readily accessible components make maintenance a fast, simple job. Beyond normal lubrication, little maintenance is required since there are no moving parts in the control to wear out or break down.

All G-E general-purpose Thymotrol panels have a written one-year warranty—an expression of G.E.'s confidence in their reliability.

SELECT THE DRIVE YOU NEED —AND SAVE MONEY!

When you select Thymotrol drives you get the perfect combination—***outstanding performance at low price.*** See your G-E Apparatus Sales engineer today or write for Bulletins GEA-6234 and GEA-6519 to Sect. 791-4, General Electric Co., Schenectady 5, N. Y. ***Specialty Control Dept., Waynesboro, Va.***

*Reg. Trade-mark of General Electric Company.

†1/10 HP, 220-volt AC input, general-purpose Thymotrol drives.

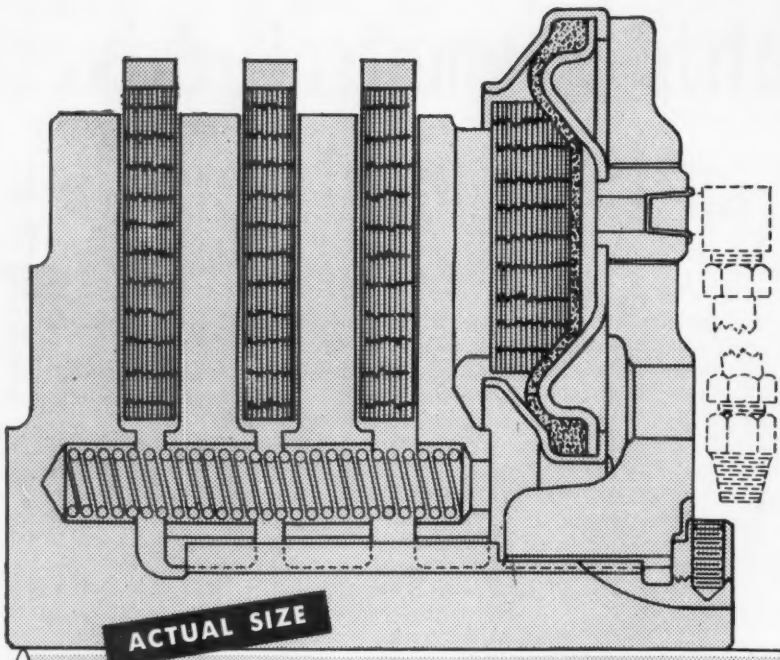
Progress Is Our Most Important Product

GENERAL ELECTRIC

COMPARE AND PROVE GENERAL ELECTRIC'S SUPERIORITY

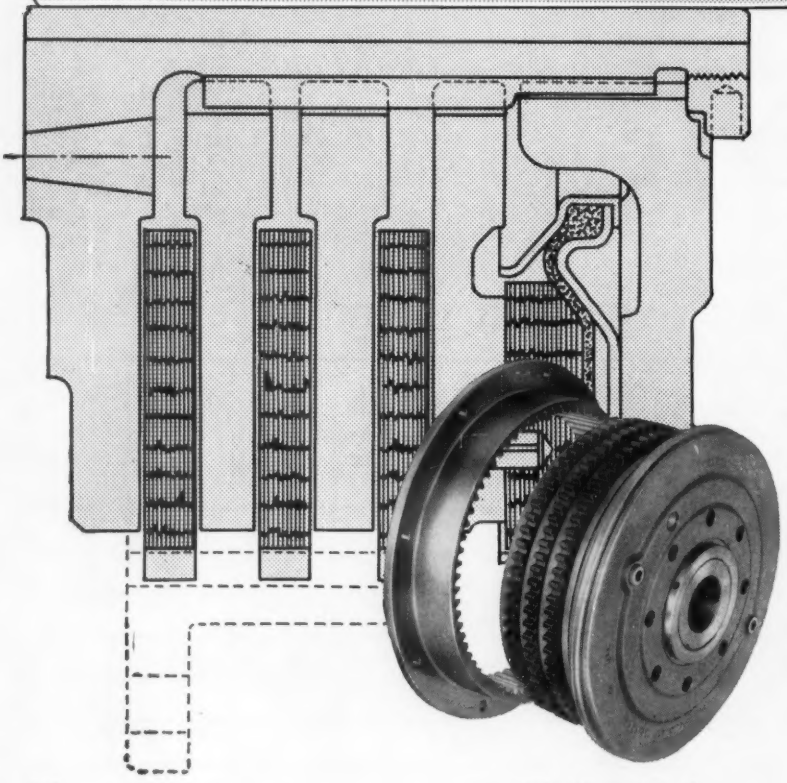
FEATURES	G-E THYMOTROL DRIVE	DRIVE A	DRIVE B	DRIVE C	DRIVE D
Speed range of 20 to 1 or more	✓			✓	✓
Printed circuitry	✓		✓		
Flat regulation at any pre-set speed	✓		✓		
Current limit acceleration	✓				
Regulation of 5% or less	✓		✓	✓	
Quick slowdown	✓	✓			
New NEMA motor sizes	✓				

Circle 488 on page 19



- **New design permits highest capacity at up to 40% less cost than comparable remote controlled air clutches!**
- **Available in sizes 8, 10 and 11½ inches . . . in triple-plate, double-plate and single-plate construction . . . with maximum torque capacity of 3503 pound-feet.**
- **Exclusive cartridge-type diaphragm of long-lasting neoprene reinforced with nylon . . . eliminates leakage and provides long life.**
- **Provides constant torque capacity without adjustment . . . self-compensating for wear.**
- **Compact and rugged . . . with clutch mass properly distributed relative to friction area, providing long life on high energy loads.**
- **Narrow width permits replacement of old-style drum or band clutches.**
- **Suitable for air systems up to 130 pounds per square inch.**

New LOW COST high capacity Twin Disc Air Clutches



The new Twin Disc 8, 10 and 11½-inch PO Air Clutches are adaptable wherever the convenience of remote air control is desired. They are currently in use on rock crushers, tractor winches, pipe-extruding machines, drilling rigs, machine tools, pug mills and other equipment.

The three new sizes extend the time-tested, job-proved line of PO Air Clutches from 8 to 36 inches in diameter . . . in torque capacities to 126,600 pound-feet.

Check your next design . . . see for yourself how PO Air Clutches lend themselves to convenient, economical remote control. Write Twin Disc Clutch Company, Racine, Wisconsin.

TWIN DISC

TWIN DISC

Friction Clutches and Fluid Drives

Circle 489 on page 19

MACHINE DESIGN
September 19, 1957

Unity for What?

MANY engineers have tacitly assumed that strong professional unity is a desirable goal. Yet the response of rank-and-file engineers toward plans for unity has, by and large, not been enthusiastic.

But if engineers are apathetic, what of the general public we are supposed to serve? There are indications that laymen look with actual suspicion on engineers' efforts to build a strong organization.

Public fear of organizations that can become nationally powerful is not without foundation. Despite their generally high ethical and professional standards, doctors are often thought to be too closely banded together for the public good. And labor unions make no bones about wielding their tremendous economic power for the benefit of their own members rather than for the public interest.

Thus, large existing organizations that parallel the relatively feeble groups at both ends of the engineers' spectrum—the professional societies and the collective bargainers—have created a climate of opinion unfavorable to unity of either kind.

Much of the debate over unity has stressed the need to raise the economic and professional status of the engineer. Could the failure to arouse enthusiasm for unity be attributable to that very fact?

Perhaps we need another Wickenden to reawaken our profession to its obligations as well as its privileges. Isn't the theme of *The Second Mile* the biggest factor that distinguishes a true profession?

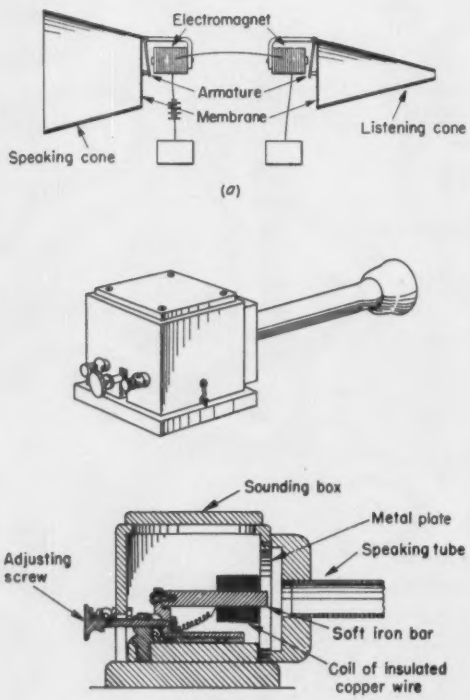
A call to service conceivably could strike a spark where an appeal to selfish interest has failed.

Colin Carmichael

EDITOR

Basic requirements of PATENTABLE INVENTIONS

By ALBERT WOODRUFF GRAY
Forest Hills, N. Y.



Early telephone inventions patented by Alexander Graham Bell. Design at *a*, which was patented in 1876, had separate speaking and listening units. Later design, *b*, patented in 1877, combined functions of transmitting and receiving in a single instrument. These patents were the subject of several court actions for infringement. Although Bell had never been able to achieve clear voice transmission with his inventions, the courts held that there was sufficient reduction to practice to validate the patents.

WHEN the owners of the basic telephone patents were fighting for the survival of their property, there appeared in the *New York Journal of Commerce* a news item of that struggle.

A New Telephone Company

A company has recently been formed in this city with a capital of $5,000,000 for the purpose of manufacturing telephones. The company is to be known as the "Peoples Telephone Company" and a number of leading capitalists in this city and Cincinnati are interested in it.

The telephones are to be manufactured under the patents of Frank A. Klemm and Abner G. Tisdel and the application for patents of Daniel Drawbaugh, of Eberly's Mills, Cumberland County, Pennsylvania, filed July 21, 1880.

It is claimed by those interested in the new enterprise that Drawbaugh is really the inventor of the telephone and had completed one years before Professor Bell or anyone else had manufactured one. He was however, in very humble circumstances and his neighbors who knew of his experiments, looked upon him as a harmless lunatic. He continued improving his original telephone and it is claimed that the one which the new company proposes to furnish is superior to any now in use.

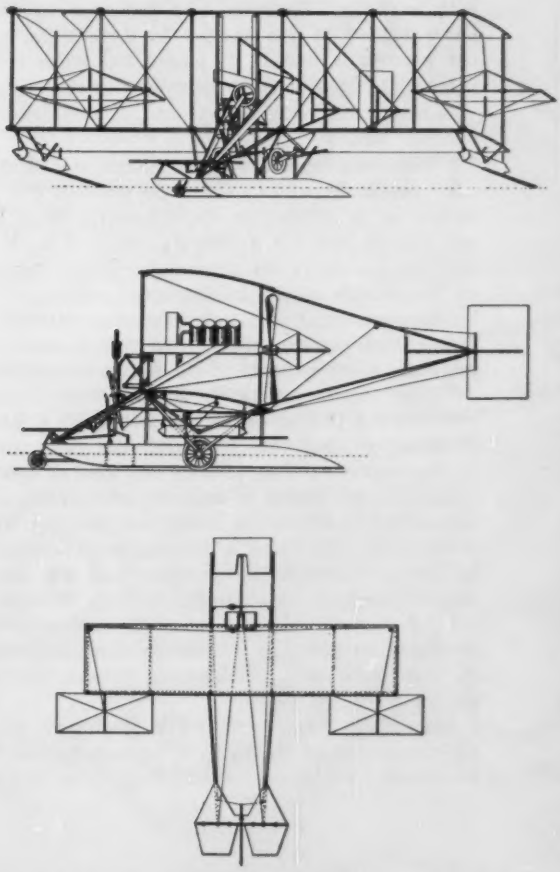
A few months after this publication, a federal court decided one of the earliest of the cases involving these telephone patents. In that long-ago decision, the feature of reduction to practice became a determining factor in the court verdict.[1]

In the words of the court, "If Bell, who is admitted in this case to be the original and first inventor of any mode of transmitting speech, had not completed his method and put it into a working form when he took his first patent, he may lose the benefit of his invention; because in his second patent he makes no broad claim to the method or process but only to the improvements upon a process assumed to have been sufficiently described in his first patent.

"There is some evidence that Bell's experiments

[1]References are tabulated at end of article.

To be eligible for a patent, an invention must be more than just an idea. It must be a practical working device or structure that can do what the inventor claims for it. But what constitutes proof that this requirement has been met? Here's how the courts have answered that question.



Early seaplane construction on which patent was issued to Glenn H. Curtiss in 1914 by court decree. Original patent application by Curtiss was denied on the basis of another inventor's application filed seven months earlier for a similar construction. In court action that followed, Curtiss won right to patent by showing that his invention was reduced to practice two days before that of the other inventor.

with the instruments before he took out his patent were not entirely successful. But this is now immaterial for it is proved that the instrument will do the work whether the inventor knew it or not and in the mode pointed out by the specification."

To this statement, the court added the comment, "Bell discovered a new art—that of transmitting speech by electricity—and has a right to hold the broadest claim for it which can be permitted in any case; not to the abstract right of sending sounds by telegraph without any regard to means but to all means and processes which he has both invented and claimed."

SEVERAL years later, the controversy over these famous patents was finally settled by the United States Supreme Court. Concerning the feature of reduction to practice, it said:[2]

"But it is insisted that the claim cannot be sustained because when the patent was issued Bell had not in fact completed his discovery. While it is conceded that he was acting on the right principle and had adopted the true theory, it is claimed that the discovery lacked that practical development which was necessary to make it patentable. In the language of counsel, 'There was still work to be done and work calling for the exercise of the utmost ingenuity and calling for the very highest degree of practical invention.'

"It is quite true that when Bell applied for his patent he had never actually transmitted telegraphically spoken words so that they could be distinctly heard and understood at the receiving end of his line. But in his specification he did describe accurately and with admirable clearness his process,—that is to say, the exact electrical condition that must be created to accomplish his purpose,—and he also described with sufficient precision to enable one of ordinary skill in such matters to make it, a form of apparatus which, if used in the way pointed out, would produce the required effect, receive the words and carry them to and deliver them at the appointed place.

"The particular instrument which he had and which he used in his experiments, did not, under

the circumstances in which it was tried, reproduce the words spoken so that they could be clearly understood."

Then, in its conclusion relating to the method and extent of reduction to practice demanded by the patent law, the court stated: "The law does not require that a discoverer or inventor, to get a patent for a process, must have succeeded in proving his right to the highest degree of perfection. It is enough if he describes his method with sufficient clearness and precision to enable those skilled in the matter to understand what the process is and if he points out some practicable way of putting it in operation."

THE requirement of the patent law that an inventor, before he can be granted the protection of a patent for his discovery, must have not a mere idea but a product that will work and perform the functions claimed for it was featured in the defense of the infringement action brought by the owners of the Bell telephone patents. It assumed an equally pronounced role in an action involving early patents of the hydro-aeroplane.[3]

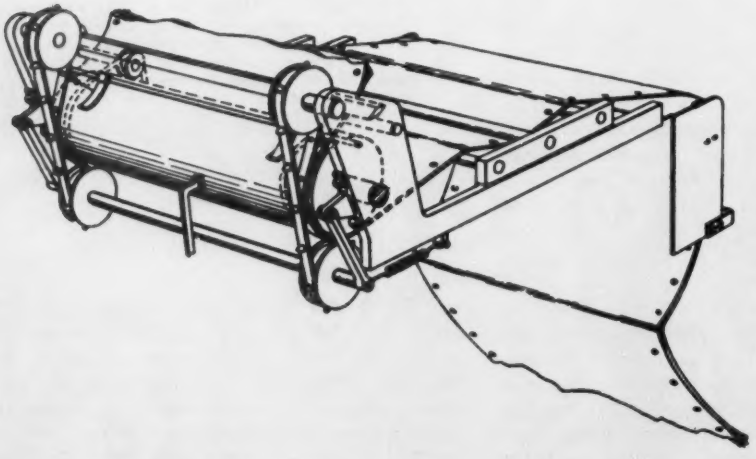
"Reduction to practice," said the federal appellate court in that decision, "is not merely a matter of structure, building and trial, but may consist in the disclosure of an idea by any kind of description, pictorial, verbal or written, which will enable one skilled in the art to make and use that which is disclosed. We think a drawing may possibly be sufficient reduction to practice and an experimental machine insufficient, for the question is one of degree, and the ultimate test is always whether the inventor has shown operative means to that theoretical omnipresent person, the man skilled in the art."

Regarding the fact that the challenger of the Curtiss patent of the hydro-aeroplane disclosed no boat body, the court added, "Let it be admitted that (the earlier inventor) had many and early conceptions of invention. They all related to a hydro-plane and he disclosed everything that he had conceived in his original specification. If therefore, that specification does not enable the man skilled in the art to construct without further exercise of the inventive faculty an operative hydro-aeroplane there has been no reduction to practice, constructive or otherwise.

"He who first conceives and in a mental sense, first invents a machine, art or composition of matter, may date his patentable invention back to the time of its conception if he connects the conception with its reduction to practice by reasonable diligence on his part so that they are substantially one continuous act."

SEVERAL years later in a case before the United States District Court in New Hampshire, a controversy had arisen over the priority of invention of two claims for a portable standpipe. In the decision of that case, the law outlined in the earlier hydro-aeroplane patent dispute was followed as authority. Here, however, the court summarized the features governing priority claims of invention and the role played by the provision of reduction to practice.[4]

"When two patents for the same invention have been issued two independent inventors, the dates of their respective inventions are first, the dates of the patents; second, the dates of the applications provided the application sufficiently describes the inventions; third, the dates of actual reduction to practice; fourth, the dates of conception, with this qualification that if either patentee seeks to carry the date of his invention back to the date of his conception, he must show reasonable diligence in adapting and perfecting his invention, either by actual reduction to practice or by filing his application."



Typewriter paper-feeding device that was cited by Commissioner of Patents in denying a patent on a similar mechanism by another inventor. In a court suit to compel issuance of a patent on his design, the other inventor claimed earlier reduction to practice although his patent application was filed ten days after that for the device shown. However, decision of Commissioner of Patents was upheld by court on the basis that the machine of the other inventor had been set aside and forgotten for several years.

A MORE detailed analysis of the application of this reduction to practice feature of the patent law was outlined in a suit brought to secure the issuance of a patent for a typewriter attachment. The patent had been denied by the court on the grounds of neglect of the invention by the discoverer for over eight years.

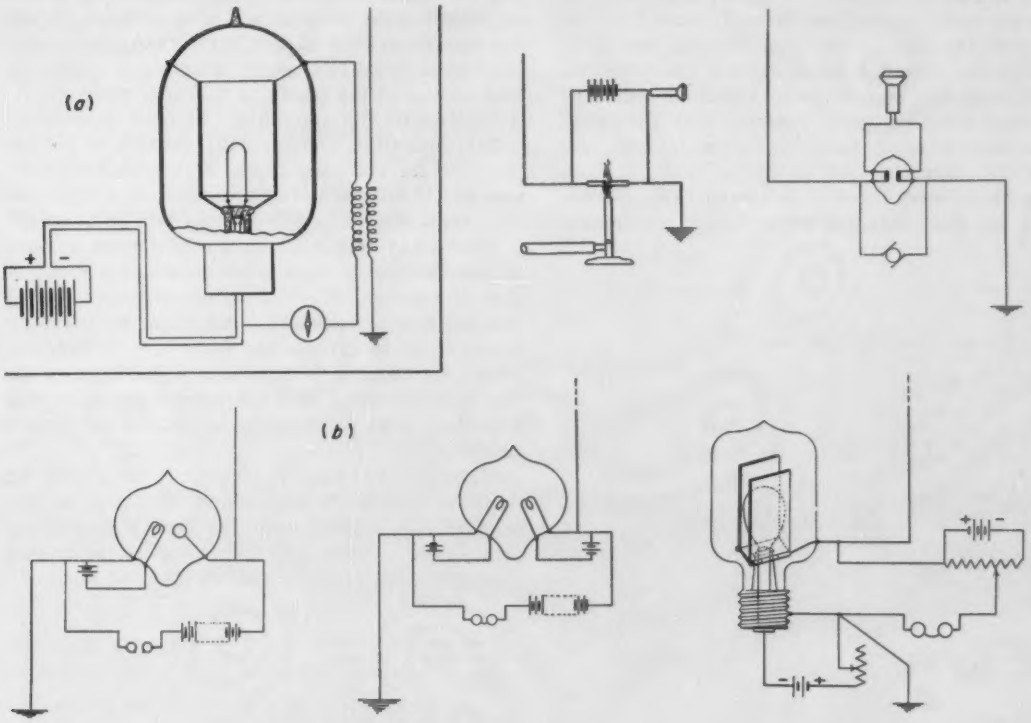
"An invention is not completed by merely thinking about it or making drawings but by actually making a model of the device which does not require further inventive work to make it serve the purpose desired. Reduction to practice means 'Nothing must be left for the inventive genius of the public;' and his invention must show this for itself before he is entitled to a patent.

"Actual employment of the machine is not necessary where its availability for use is apparent from an inspection of the invention itself. Yet where nothing else than such employment can afford this evidence, as in the case of an art or chemical compound and sometimes of machines and manufacturers, such tests must be applied as will determine that the end which it purports to serve, can be accomplished.

"Mere conception as evidenced by a drawing of any kind or description does not constitute reduction to practice. It is the actual test of the machine and not the time of its conception that is essential to establish reduction to practice. A reduction to practice is accomplished when the inventor's conception is embodied in such form as to render it capable of practical and successful use."

Then, based on the various rulings by the courts, the principles governing the necessity for a reduction to practice were divided into three groups:[5]

1. Devices so simple and of such obvious efficacy that construction of one, of a size and form intended for and capable of practical use, is wholly sufficient without tests in actual use.
2. Those instances where a machine which embodies every essential element of the invention, having been tested and its practical utility for the intended purpose demonstrated to a reasonable satisfaction, has been held to have been reduced to practice notwithstanding the fact that it may not be a mechanically perfect machine.
3. Those instances where the machine is of such a character that the particular use for which it is intended must be given special consideration



Early radio tube constructions involved in a court action for infringement. Design at *a*, patented in 1905 by John Ambrose Fleming of London, was assigned to Marconi Wireless Telegraph Co. of America. Devices shown at *b*, along with others which were all patented from 1906 to 1910, were cited in defense of an infringement action by Marconi. Although Fleming could not explain completely the scientific principles of his device for converting alternating current into direct current, the court in a decree for Marconi held there was sufficient reduction to practice to validate the patent.

and require satisfactory operation in the actual execution of the object.

MEETING the requirement of reduction to practice that is made compulsory by the patent law does not mean that the inventor should be conversant with all the natural laws or underlying principles of physics involved in his invention. It is as Einstein has said, that science can deal only with the function and interaction of matter but can never know or penetrate into the nature of matter.

Suit was brought many years ago by the Marconi Wireless Telegraph Co. for the infringement of a so-called Fleming patent for converting alternating electrical currents into those that are continuous. "Stripped of technical phraseology," said the federal court, "it was to take a well known Edison hot and cold electrode incandescent lamp and use it for a detector of radio signals."

Concerning this invention, and the inventor's inability to explain the principles involved, a federal court made the observation,[6] "The patentee may not understand his own mechanism but if he shows and describes it and it produces a new result the law is satisfied."

This comment followed an earlier statement of the same rule by another federal court:[7] "It is true that the statute provides that in case of a machine the inventor shall explain the principle thereof and the best mode in which he has contemplated applying that principle. The first provision cannot mean that the inventor must infallibly explain the law of nature which makes his machine work. For if it means that, neither Morse nor Bell complied with it when describing the telegraph or telephone.

"The first provision means that the essential distinctive characteristic of the machine shall be explained. The inventor is entitled to all the beneficial uses of his invention which are sufficiently pointed out and described. If such description of means be sufficient to confer upon the public the beneficial result, it is immaterial whether or not the inventor understood the scientific principle of its operation."

This rule was succinctly phrased in a recent comment[8] by a court in the District of Columbia: "Patents are granted on structures rather than on ideas under our patent law and the mere fact that an inventor is unable to foresee the possibilities of the structure that he devises, does not detract from its force and effect as prior art."

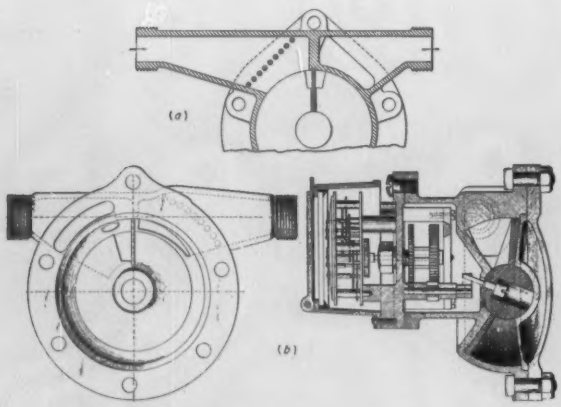
Before a federal court recently, for review on appeal, was an action by a manufacturer of electronic equipment for a patent on a radar device. The patent had been awarded to a senior applicant who had filed his application eight days before that of the manufacturer. This senior inventor however, had rested his claim to priority on a French filing made a year before.

Basis of the claim of the manufacturer to this patent was that during the year prior to the filing of its application it had, in its radio research, set up an apparatus on the top of one of its buildings and proceeded to operate the apparatus in sighting objects near at hand and at a distance. While the apparatus located buildings, smokestacks and the like, it failed in a proper orientation, indicating land objects in the middle of a nearby river. Shortly afterwards the apparatus had been dismantled.

This operation, the company claimed in its application for the patent, was a reduction to practice which entitled it to the patent. In a denial of that application, the federal appellate court said:[9]

"There has been built up a considerable amount of case authority upon what constitutes a reduction to practice. We find no disagreement among the decisions; indeed, the language of them all seems to us to express the same idea in different ways. We think it is clear that reduction to practice does not mean that whatever is being worked upon has to be in shape to be commercially marketable.

"On the other hand it must be a demonstration that the inventor's idea works, not that he has thought the matter out and devised something that ought to work and may work but something that will work to accomplish its intended purpose."



Early water-meter designs with "nutating" pistons which were patented by the same inventor. Design at *a* was patented in 1894 and that at *b* in 1895. In an infringement action by the meter company to whom the patents were assigned, the court dismissed first patent for lack of reduction to practice but awarded verdict to company on basis of second patent.

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2. Dolbear v. American Bell Telephone Co., 126 *U.S.*1, March 19, 1888.
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4. Corley v. Robinson, 3 *F.S.* 176, New Hampshire, April 21, 1933.
5. Sherman v. American Tel. & Tel. Co., 38 *F.S.* 360, New York, April 16, 1941.
6 Marconi Wireless Tel. Co. of Am. v. DeForest Radio Tel. & Tel. Co., 243 *Fed.* 560, May 18, 1917.
7. National Meter Co. v. Thompson Meter Co., 106 *Fed.* 531, New York, October 5, 1900.
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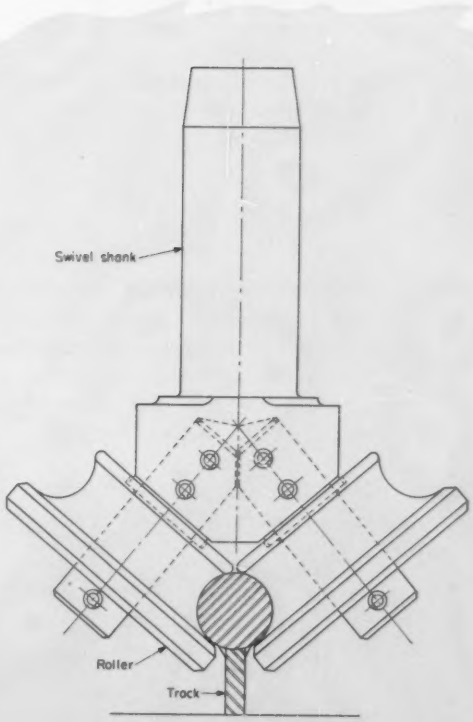
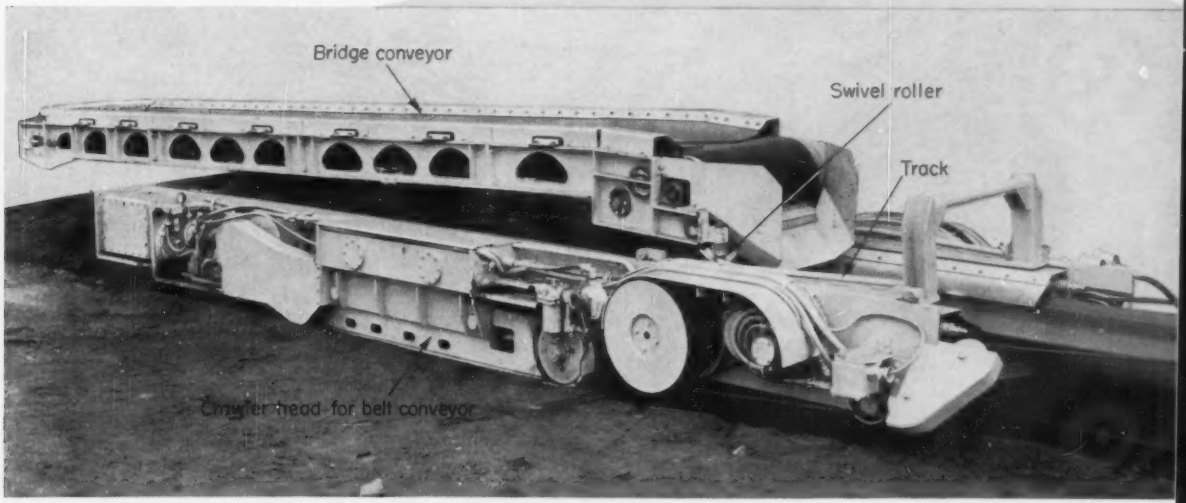
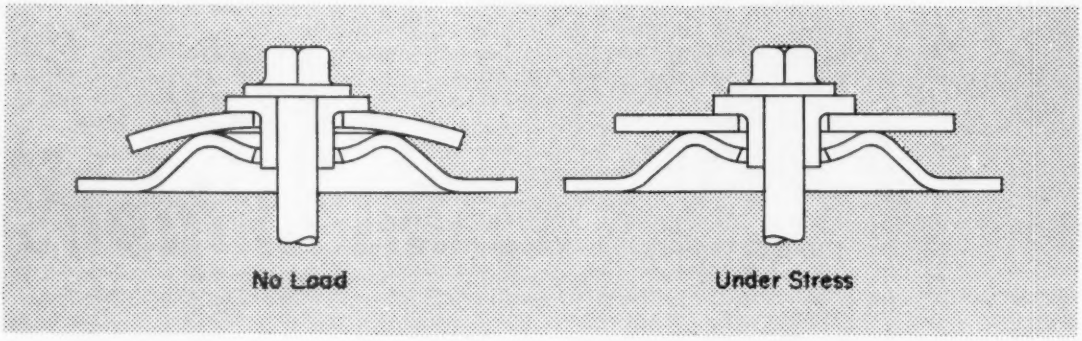
scanning the field for *ideas*

Horseshoe track-and-roller joint for large or bulky members provides a compact connection with freedom of movement in two directions. Designed by Goodman Manufacturing Co., the movable joint permits a bridge conveyor to follow the movement of a coal-mining machine. Vertical-space requirement is reduced to a minimum by the design, which employs two pairs of rollers engaging a semicircular track.

The track itself is a length of round steel bar bent to shape and welded on top of a rectangular-bar support. The track assembly is welded onto a steel plate that crosses the belt conveyor. At each corner of the bridge conveyor is a pair of swivel rollers that engages the track. The circular shape of the track and mating roller faces permits vertical movement of the bridge conveyor; horizontal movement is accommodated by the swivel rollers moving along the track contour.

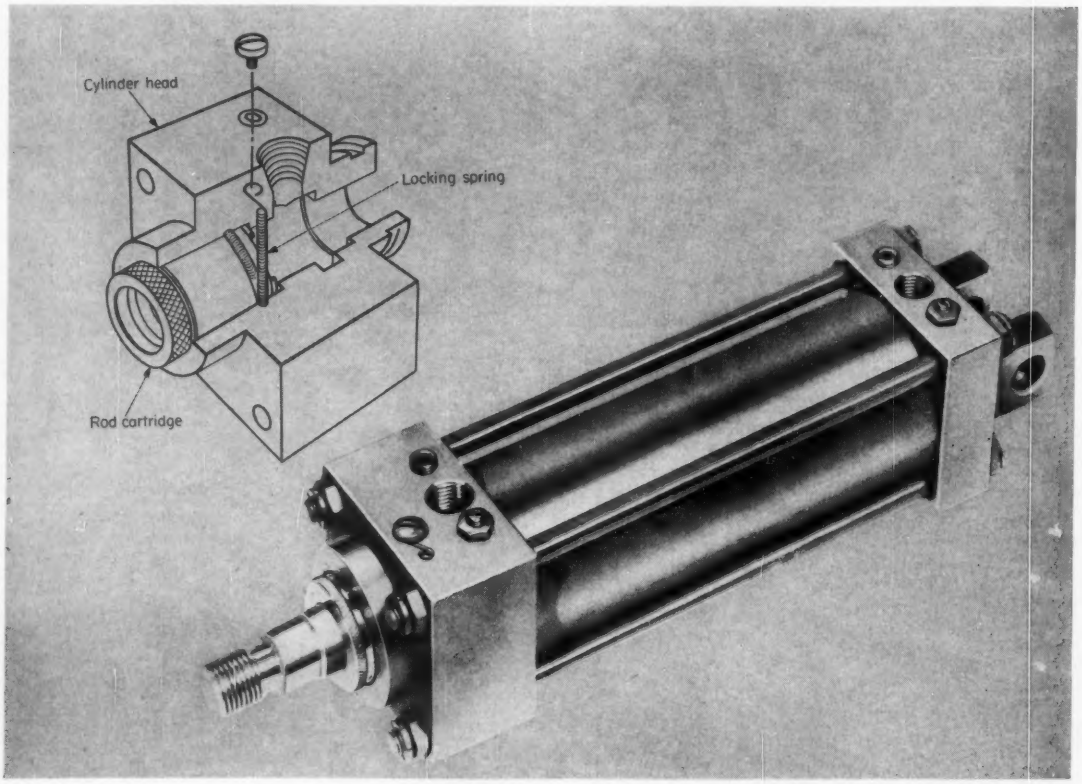






Accurate control of bolt tightening is permitted by a cupped washer design that changes shape when a specific preload is reached. Drawn flat under a predetermined tensile load, the patented washer assumes its original cupped shape when tension is reduced. The washer was developed by American Mine Supply Co. to indicate loss of tension in mine-roof supporting bolts. Direct visual indication of bolt load is provided by the design, eliminating the need for conventional torque-measuring methods in bolt assembly.

Coil-spring locking of cylindrical joints holds parts securely yet permits easy disassembly. In an air-hydraulic cylinder designed by Teer-Wickwire & Co., the rod cartridge and the cylinder head have matching grooves. A hole in the head, tangential to the groove, permits insertion into the groove of a tightly wound coil spring. The coil spring locks the cartridge into the cylinder head, yet is easily removed for replacement of parts.



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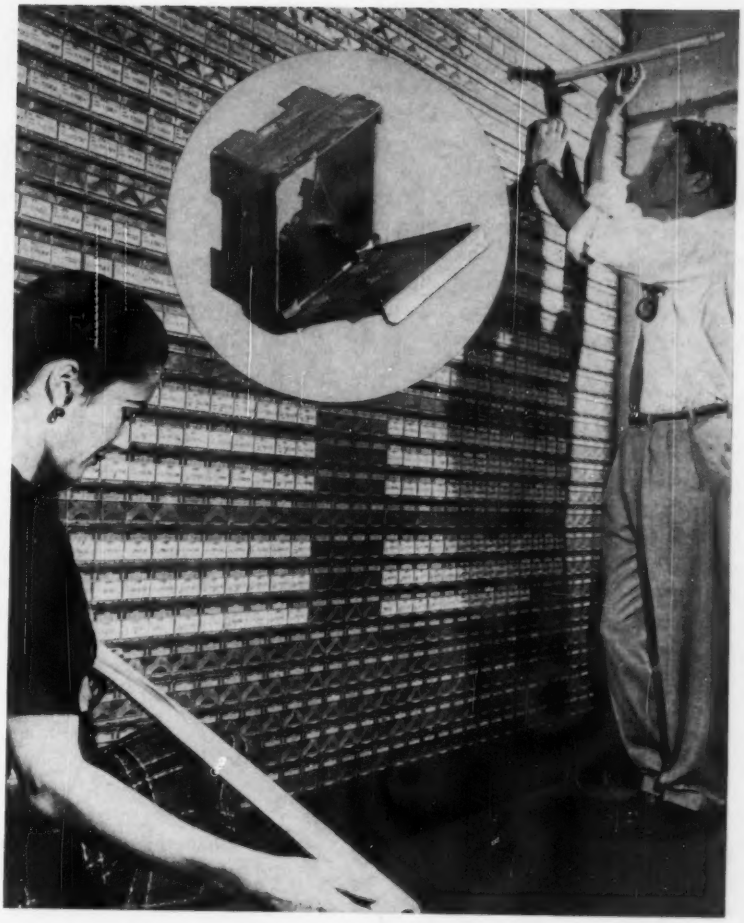
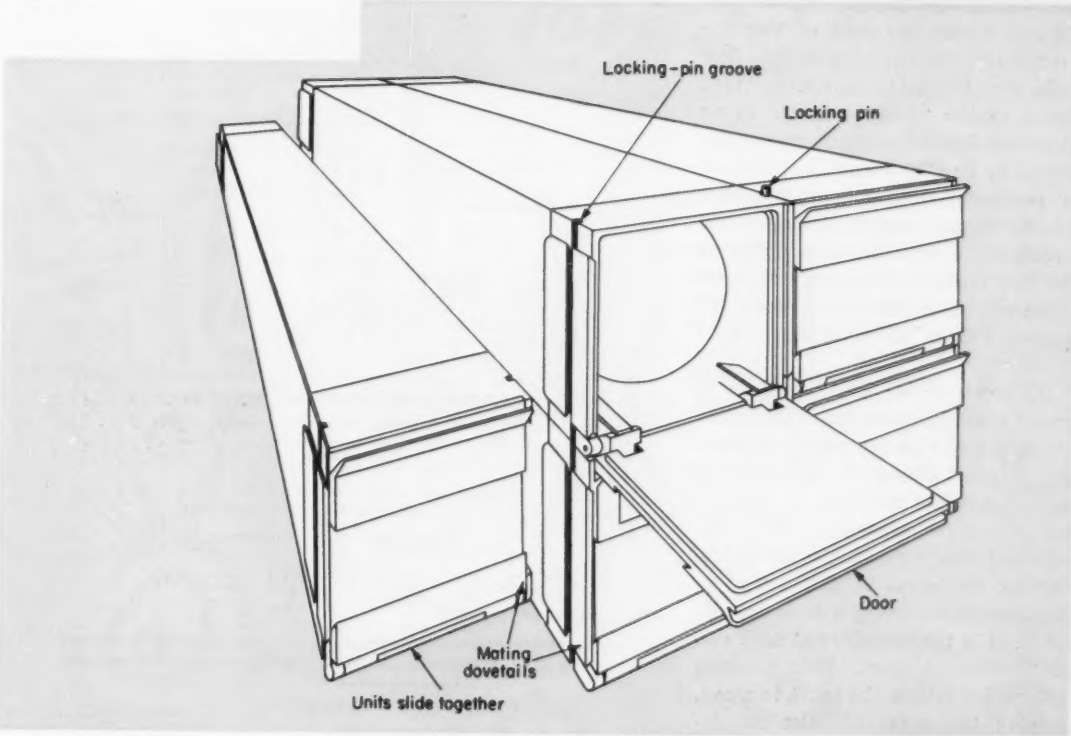
Keyed dovetail joints permit interlocking small individual parts into a solid unit. Each part has a male and female dovetail, on opposite sides. Dovetails of adjacent parts slide together and are locked in position by a key. The design concept, developed by Peck Manufacturing Co. and reported by the American Die Casting Institute, is used in an interlocking roll-drawing file to permit assembly of many individual roll-drawer files into a solid unit.

Each file unit has a die-cast end plate at each end. Units are slid together to make horizontal rows of files. The rows are then piled up and locking pins dropped into grooves on the dovetail surfaces. The pins lock the individual units and the horizontal rows into one large, single unit.





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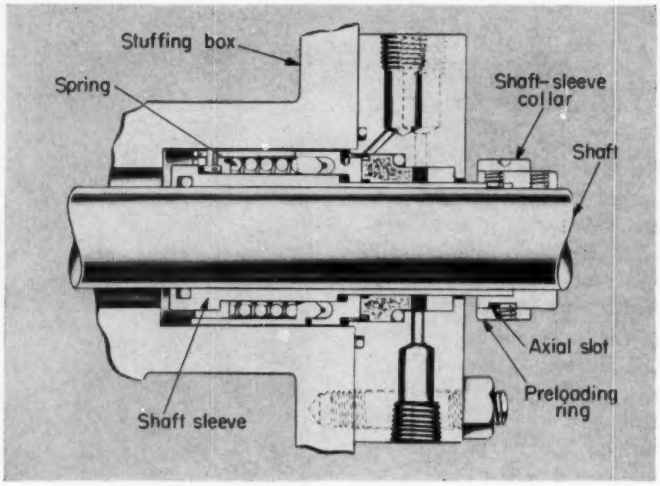
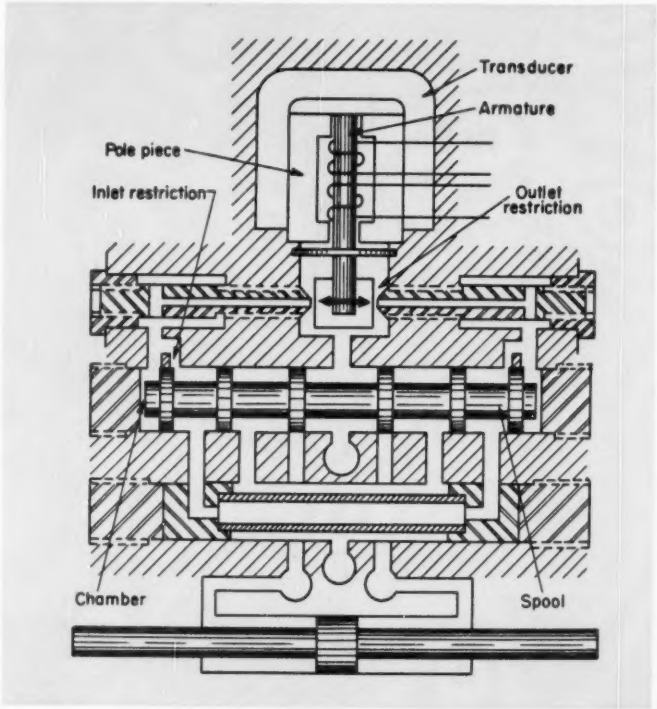
Precision preloading of a compression spring is accomplished with a novel sliding-collar arrangement. In a cartridge seal developed by Byron Jackson Pumps Inc., a compression spring is used to keep rotating contact surfaces under proper pressure. One end of the compression spring rests on a shoulder at the end of a shaft sleeve. At the other end of the sleeve, outside the seal, is an axially slotted collar. The preloading ring surrounds this collar and has a screw that engages the slot.

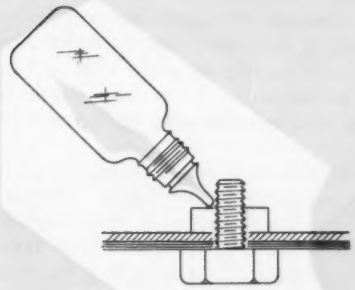
When the seal is installed, and before the seal-flange bolts are tightened, the slotted shaft-sleeve collar is locked to the shaft with a set screw. The seal-flange bolts are then tightened, compressing the spring. The preloading ring is moved axially (toward the flange) the length of the collar slot and locked in place. The shaft collar is then released from the shaft, permitting the compressed spring to pull the preloading ring into contact with the seal flange. At this position, the shaft collar is locked permanently to the shaft. The preloading ring is then loosened and withdrawn from contact with the seal flange.



Proportional flow control is obtained in a hydraulic valve by bending the armature of an electromechanical transducer. Armature deflection varies the area of two hydraulic restrictions, causing fluid flow to be proportional to the electric input signal to the transducer coil. In an electro-hydraulic control valve designed by Cadillac Gage Co., the spool is positioned by a closed-loop hydraulic control circuit. This control circuit is in equilibrium as long as the two outlet restrictions are equal —the condition that exists when the armature is in its neutral, centered position.

If, however, a direct current is passed through either coil of the transducer, the flux in the airgap between one pole piece and the armature is increased, while the flux on the opposite side is decreased. This unbalanced flux deflects the armature, varying the areas of the outlet restrictions and causing a pressure differential in the chambers at each end of the control spool. This pressure differential causes the spool to move, varying the areas of inlet restrictions. When the pressure differential between the inlet restrictions equals that between the outer restrictions, the chamber pressures are equal and the spool becomes stable at its new position.





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Hartford, Conn.

New developments in Liquid Thread-Locking Agents

characteristics of five liquid compositions recently introduced for fastener application

COMBATTING the loosening effect of vibration and shock loads on fastener assemblies is the function of a wide array of mechanical thread-locking devices. Although differing in details of design and application, almost all of these locking fasteners are based on the same operating principle: increasing the frictional drag between mating thread surfaces.

As a practical approach to this basic problem, a family of liquid thread-locking agents has recently been introduced for application on fasteners of standard thread form. These liquid compositions, which are tradenamed Loctite, can be applied to either internal or external thread surfaces to develop a frictional locking action with prevailing-torque characteristics. A series of locking strengths is provided, permitting variation of torque characteristics to suit application requirements. Salient features of these compositions as a method of thread locking are considered here.

Basic Application Considerations: Five grades of liquid compositions have been developed for thread-locking applications, Table 1. Resembling kerosine in physical appearance, these liquids are basically nonvolatile, thermosetting plastic materials which cure readily at room temperature. All have the same viscosity except Grade D, which is a high-viscosity version of Grade A for use in loose-fitting threaded joints.

Table 1—Properties of Different Grades of Liquid Thread-Locking Compositions

Property	Grade A	Grade D	Grade C	Grade E	Grade H
Shear strength (fully cured), psi	750-1000	750-1000	300-400	150-200	75-100
Viscosity (liquid), centipoise	10-15	40-50	10-15	10-15	10-15
Volatiles, per cent	<2	<2	<2	<2	<2
Flashpoint, F	>200	>200	>200	>200	>200
Cure time (75 F), hr	12	12	12	12	12
Gel time (between crossed steel strips), minutes	<10	<10	<10	<15	<15
Solubility in:					
Acetone	miscible	limited	miscible	miscible	miscible
Trichloroethylene	miscible	miscible	miscible	miscible	miscible
Water	insoluble	insoluble	insoluble	insoluble	insoluble

When confined between two closely fitting metal surfaces, the liquid compositions convert to solid form in less than 10 minutes. The solid continues to harden and gain strength on further standing at room temperature, reaching a final cured condition (maximum strength) in 24 hours. However, cure time can be accelerated by pretreating the metal surfaces with a special activator solution which develops maximum strength within a few hours. Heat also can be used to speed up hardening, but the results are not so consistent as those obtained with long cures at room temperature.

Hardening of the liquids is produced by two actions: (1) the catalytic effect of the metal surfaces and (2) the exclusion of air, the presence of which stabilizes the compositions in liquid form. The liquids are applied in small amounts to the threaded surfaces, either before or after assembly. Capillary action draws the thin liquid into the joint and distributes it evenly over the thread surfaces, much like penetrating oil.

In hardened form, the liquids become a clear transparent plastic material. Characteristics range from a hard amber-like composition (Grade A) to a soft, flexible material resembling art gum (Grade H). A plastic bond, acting also as a seal, fills the spaces between engaged threads to provide a secure locking action. Strength of the bond depends upon the grade of liquid used, varying from a mild torque resistance to a lock that can exceed the torsional strength of the fastener. Once this bond is destroyed, the hardened plastic coating then acts as a mechanical obstruction in the threads to develop a prevailing-torque type locking action that remains effective for a number of turns.

These plastic materials are intended for use under shear, rather than tensile, loads. Grades A, C, E, and H provide a choice of shear strengths (fully cured) from 1000 to 100 psi to meet varying disassembly requirements. Joints in through-wall parts where the ratio of engaged thread length to diameter is large should use the compositions with moderated shear strength unless the use of heat in disassembly is acceptable.

All of the foregoing four grades have high pene-

Table 2—Typical Breakloose Torques for Cured Liquid Compositions*

Nominal Thread Size	Tightening Torque (lb-in.)	Breakloose Torque (lb-in.)			
		Grade A or D	Grade C	Grade E	Grade H
¼-28	48	60	50	45	40
½-13	370	450	400	350	300

*Based on regular full nuts pretightened to bolt stress of approximately 33,000 psi.

Properties of Liquid Thread-Locking Agents

Cure Time

Initial hardening of the liquid composition begins within 10 minutes after confinement between metal surfaces. More than 50 per cent of final strength is reached in all cases in 6 hr. For threaded fasteners, a locking torque of about 85 per cent of the final value is reached in twelve hr at 72 F. At least 24 hr must be allowed to assure that a final permanent fully hardened state has been reached.

Hardening can be accelerated by heat and is complete in 15 minutes at 212 F or 2 minutes at 350 F. Best results are obtained when the treated joint is allowed to cure at room temperature for at least 30 minutes prior to heating. Otherwise, heat may cause excessive drainage of the liquid from the joint before setting occurs.

Rate of hardening at room temperature can be hastened by treating the surfaces to be bonded with activator (tradenamed Locquic) prior to assembly. Treatment of certain surfaces, which do not in themselves catalyze the hardening of the liquid compositions, with activator is essential. Such surfaces include zinc and cadmium plating, and plastics, although use with plastics is not generally recommended.

The procedure is simply to place the parts in a wire basket and dip momentarily in a standard degreasing solvent, such as trichloroethylene, to which 5 per cent activator is added. The washed parts are then allowed to drain and dry before treatment with a liquid composition. Parts so treated will harden the sealants to maximum strength in a few hours.

Shelf Life

Under normal storage conditions in closed bottles, the liquid compositions will not harden for more than a year. However, contamination with rust or metal particles will cause hardening. These compositions are usable as long as they remain liquid, and they do not deteriorate unless hardening occurs.

Solubility

In liquid form, these compositions are soluble in most common organic solvents, but not in water.

The resistance of the cured sealants to solvents is characteristic of thermosetting plastics. Natural or synthetic lubricating oils, motor fuels, common organic solvents and water, do not affect the material. Resistance to chemical attack is also good, although hot concentrated mineral acids and alkalis will slowly attack it.

Handling Considerations

Containers or equipment which have been used in the handling of these liquids can be washed out prior to hardening with a degreasing solvent such as trichloroethylene. Hardened compositions can be removed by long boiling with caustic soda, followed after rinsing, by wire brushing.

Care must be taken to avoid damage to organic finishes by contact with the liquids. Lacquer type finishes are softened immediately. Baked enamel finishes are not harmed by several hours contact. If treated assemblies

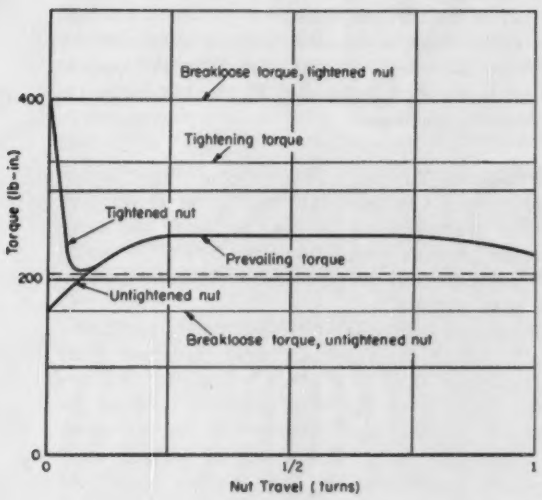

Fig. 1—Torque characteristics of tightened and untightened 3/8-24 nuts treated with a liquid thread-locking composition (Grade A). Dashed horizontal line represents breakloose torque of tightened untreated nut.

trating power and are intended for use in closely fitting joints having radial clearance of 0.002-in. or less. Grade D, the high-viscosity version of Grade A, is intended for loose-fitting joints with radial clearance of 0.002 to 0.005-in. All grades are essentially nonvolatile and nonflammable at room temperature. On heating to determinate flash point, the liquid compositions convert to solids in the temperature range of 200 to 300 F before the flashpoint is reached.

Practical information on the characteristics and use of these liquid compositions for thread sealing and locking is presented in *Properties of Liquid Thread-Locking Agents*. Factors influencing selection and application of these compositions are analyzed in the following discussion.

General Torque Characteristics: Torque required to loosen a "treated" nut over the first full turn under different conditions is shown in Fig. 1 for a representative assembly. The upper left "fork" of the curve applies to a nut which has been tightened down against the part to be fastened before an ample amount of sealant was applied at one end of the nut. Here, initial or breakloose torque required to start the nut is substantially the same as the prevailing torque. Tightening torque is the torque required to tighten the nut down against the part. Breakloose torque of the untightened nut is the torque required to start the nut from the fully tightened position. Prevailing torque is the torque required to maintain motion of the nut after breakloose torque has been overcome.

Breakloose torque of the tightened nut is usually greater than the prevailing torque. Breakloose torque of the untightened nut is usually greater than the tightening torque. Breakloose torque of the untightened nut is usually greater than the breakloose torque of the tightened nut.

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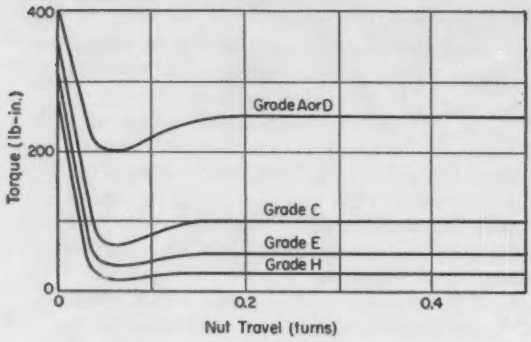

Fig. 2—Comparison of torque characteristics of 3/8-24 nuts treated with different grades of liquid compositions. All nuts were torqued tight to a tensile bolt stress of 33,000 psi.

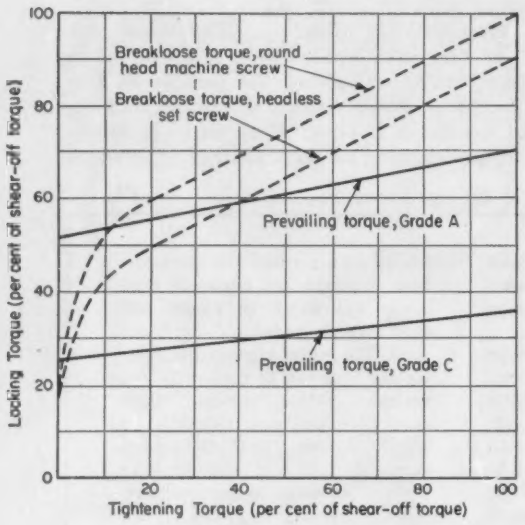

Fig. 3—Effect of tightening torque on locking action of cured liquid compositions.

tially higher than tightening torque. The breakloose torque of an untreated nut tightened to the specified torque is shown by the horizontal dashed line. The difference between breakloose torques of the treated and untreated tightened nuts is due to the bonding action of the sealant on the threads and on one face of the nut.

When the bond of the tightened treated nut is ruptured, torque resistance drops rapidly for the first few tenths of a turn, then steadies on a plateau which is the prevailing torque. This torque resistance, which continues steady as the nut is turned, is due to the jamming action of plastic in the threads.

The lower fork of the curve applies to a treated nut on an unloaded bolt (zero tightening torque). Here the initial torque is lower and rises during the first few tenths of a turn to the same plateau as in the preceding case. The breakloose torque in this case is due to the bonding action of the sealant on the threads alone.

A comparison of locking torques developed by ordinary nuts treated with the different sealant grades is shown in Fig. 2. Tightening torque is the same in each case.

Breakloose Torque: Factors controlling breakloose torque are thus different from those controlling the prevailing torque. Shape of the curve describing torque versus turns can be readily varied over a substantial range to meet different application requirements.

Breakloose torque is controlled mainly by the degree to which the fasteners were tightened prior to treatment and, to a lesser extent, by the torsional strength of the bond produced between the engaging threads and between the nut or screw head and the part. The grade of sealant used, therefore, has much less effect on the breakloose torque than on the prevailing torque.

Effect of tightening torque on locking action of the sealants is shown in Fig. 3. With no load on the bolt, the breakloose torque is substantially less than the prevailing torque. As the tightening torque is increased, the breakloose torque increases rapidly. However, the prevailing torque rises more slowly and the curves soon cross.

At normal bolt stresses, there is little difference between the breakloose torques of the different grades, Table 2. The contribution to the breakloose torque of the bond between the screw head and the work is shown by comparison, Fig. 3, of the curves for a round-head screw in a tapped hole and a headless set screw in a shaft collar. Note, however, that the breakloose torque developed by the cementing of the screw head does not contribute to the torsional stress on the screw. It does increase the chance that the slotted head might be damaged in disassembly with a screw driver but does not increase the chance of the screws shearing off.

The effect of tightening torque is particularly important in applications where it is desired to apply maximum prevailing torque to a machine screw without danger of marring the slotted head during breakloose, as for instance in holding a light part to a casting. By selecting a strong sealant grade and, at the same time, reducing the high tightening torque normally used, the breakloose torque can be reduced while the prevailing torque is raised, until maximum holding power is achieved. High tightening torque is frequently specified simply to help secure untreated screws but may not be required when a sealant is used. As the length of engagement increases, breakloose torque naturally departs less and less from prevailing torque. It loses significance when the engaged length of screw thread is more than three times the pitch diameter.

Prevailing Torque: In fasteners subject to impact, prevailing-torque characteristic of the locking

device becomes particularly important. It is a measure of the energy required to remove the screw and, hence, of resistance to loosening under impact and vibration loads.

Two concepts are useful in analyzing prevailing-torque action of locking fasteners. The first is engagement ratio R_e which is defined as the ratio of engaged length of screw (L_e) to its pitch diameter (D_p). This ratio is a measure of the balance of strength of a fastener assembly with respect to stripping of the threads versus tensile rupture of the screw. In most fastener applications, the engagement ratio falls in the range 0.5 to 5.0.

Another useful concept is that of holding power P_h, which is defined as the ratio of prevailing torque T_p to torsional strength T_s, or "blind hole shearing torque," of the screw. A holding power of more than 1.00 means that the screw will shear off before it can be disengaged. A holding power of 0.10 means that the prevailing torque is 10 per cent of that required to shear the screw. One advantage of this expression is that screw diameter is eliminated as a variable.

The prevailing torque developed over a range from 1/10 to 1 turn of a sealant-treated screw depends on the engaged length of the screw, its pitch diameter and the strength of the grade of sealant used. Typical prevailing-torque values for different screw diameters and engagement ratios are tabulated for five grades of liquid sealants in Table 3.

Engagement ratio above which screws treated with the different composition grades will shear off on attempted disassembly at room temperature are shown for several standard fastener materials in Table 4.

Holding power of the different grades of liquid compositions at engagement ratios up to 5 is depicted graphically in Fig. 4. If a vertical line is drawn through the point on the horizontal axis of these graphs corresponding to the engagement ratio of a specific screw application, the intercepts of each liquid-composition grade sector with this line define the range of holding power developed by that liquid-composition grade in the screw engagement. Thus, for example, a treated mild-steel screw in a tapped hole with $R_e = 2.5$ will have a holding power range of 9 to 20 per cent with Grade H, 20 to 46 per cent with Grade E, 35-80 per cent with Grade C, and more than 100 per cent with Grade A.

All data presented here apply to fasteners that have been fully impregnated with sealant. Complete impregnation is readily achieved by methods which will be discussed later for intermediate engagement ratios and fits of class of 2 or better. With loose fits and small engagement ratios, a higher-viscosity sealant grade is necessary to provide full impregnation. In some cases, repeated treatment with a sealant may be required to obtain desired results.

Reproducibility of Results: Locking torque is not an exact quantity. It varies considerably because of factors such as: differences in clearances between engaging threads, even within the same class of fit; lubrication of joint by liquid sealant "wicking in" after breakloose from threads outside the joint; temperature rise from heat of friction as screw is turned; etc. However, with a little practice these data can generally be reproduced for each screw size with an accuracy of ±40 per cent over a tenfold range of engagement ratios and a tenfold range of sealant strengths.

Application Details: These liquid compositions can be applied to thread surfaces either before or after the fastener is tightened to final torque value. Good bonds can be obtained with no surface preparation when clean parts of common metals are used. Parts that have been greased to prevent rusting require simple solvent degreas-

Table 3—Prevailing Torque Characteristics of Cured Liquid Compositions

Nominal Screw Size	Prevailing Torque (lb-in.)								
	$R_e = 0.5$*	$R_e = 1.0$*		$R_e = 1.5$*		$R_e = 2.5$*		$R_e = 5.0$*	
	Grade A or D	Grade A or D	Grade C	Grade A or D	Grade C	Grade C	Grade E	Grade E	Grade H
No. 2	0.5-1	1-2	0.5-1	2-4	1-2	1-2	0.5-1	1-2	0.5-1
3	1-2	2-4	0.5-2	3-6	1-3	2-4	1-2	2-4	1-2
4	2-4	3-6	1-2	4-9	2-4	3-6	2-4	3-6	2-4
5	2-5	4-9	1-3	6-14	2-5	4-9	2-5	4-9	2-5
6	3-6	5-11	2-4	7-16	3-7	5-11	3-6	5-11	3-6
8	4-10	9-20	3-8	14-30	5-12	9-20	4-10	9-20	4-10
10	6-15	13-30	5-12	20-45	8-18	13-30	6-15	13-30	6-15
No. 12	10-22	20-45	8-18	30-70	11-27	20-45	10-22	20-45	10-22
1/4	17-40	35-80	13-30	50-120	20-50	35-80	17-40	35-80	17-40
5/16	35-85	70-170	30-65	105-250	45-100	70-170	35-85	70-170	35-85
3/8	75-170	150-350	60-140	220-500	70-160	150-350	75-170	150-350	75-170
7/16	95-220	190-440	75-170	290-660	110-260	190-440	95-220	190-440	95-220
1/2	150-325	300-650	110-260	450-1000	160-400	300-650	150-325	300-650	150-325
	Prevailing Torque (lb-ft)								
9/16	15-40	35-80	14-35	50-120	20-50	35-80	15-40	35-80	15-40
5/8	25-55	50-110	20-45	75-170	30-70	50-110	25-55	50-110	25-55
3/4	40-100	85-200	35-80	130-300	50-120	85-200	40-100	85-200	40-100
7/8	65-160	135-320	55-125	200-480	80-190	135-320	65-160	135-320	65-160
1	100-200	200-465	80-185	300-700	120-280	200-465	100-230	200-465	100-230

*R_e = Engagement ratio = L_e/D_p.

ing. Small amounts of rust will actually strengthen the sealant bond.

Some unusually smooth finishes such as bright nickel or chromium plating give relatively weak bonds and must be roughened with an abrasive to develop required strength. Also, some chemically inert surfaces such as zinc, cadmium, or gold platings and plastic moldings, require treatment with an activator solution before hardening of the bond will occur.

For preassembled fasteners, the liquid is usually applied through tube or nozzle dispensers and wicks into the joint by capillary action. Loosely fitting joints usually require more than one treatment to assure complete sealing.

For threaded parts treated before assembly, surfaces to be joined are first wet with the proper grade of sealant by nozzle application, brushing, dipping, or tumbling. The liquids spread rapidly to cover the thread surfaces. Approximately 1 cu cm of sealant is used per 50 to 150 sq in. of surface, depending upon assembly conditions. Ideally, the thread surfaces should be merely moist with a thin film of sealant which can be retained. Excess sealant should be avoided so that surfaces are not too wet and drain off.

The external surfaces of small parts may be treated in large batches at minimum cost by tumbling. This technique applies a uniform coating of proper thickness over the entire surface. Since the sealant remains liquid while exposed to air, the treated fasteners can be assembled with hand tools as easily as untreated fasteners. Treated steel fasteners can be stored a day or two before use; however, treated brass fasteners have a storage "life" of about 8 hr. With this method of application, 50 cu cm of sealant will cover about 10,000 machine screws of No. 4 × ⅜-in. size.

Where internal thread surfaces are to be treated, dipping, brushing or spraying are recommended methods of application. For automatic application, the liquid can be piped to a continuous feed brush. Selection of the best method of liquid application will depend on the fastener type and size as well as production and assembly conditions.

For commonly used styles of nuts, engagement ratios usually fall within fairly narrow limits, R_e = 0.8 to 1.0. To develop maximum gripping strength when ordinary nuts are used on steel screws, sealant Grades A or D are recommended. Both give a holding power of from 25 to 80 per cent of the torsional strength of the screw. When used with aluminum screws, or with some brass screws, nuts should be treated with Grade C, which gives a holding power of from 15 to 45 per cent of the torsional strength of the aluminum screw. On steel screws, an ordinary nut treated with Grade C would only give a holding power of from 10 to 25 per cent of the torsional strength of the fastener. However, this value is well suited for adjustment use. Tumbling is not recommended as a method of sealant application on nuts, since it does not coat the internal thread surfaces.

In stud applications, a Class 2 fit is recommended instead of the commonly used Class 5 tap-end interference fit. Studs can be driven by hand with the locking action developing after the stud is in place. A fluid-tight assembly can be easily obtained by using enough sealant to fill the joint completely. If nuts used on the studs are also to be treated, the sealant grade used should be such that the product of the relative torque of the sealant times the engagement ratio of the nut is less than half the product of the relative torque of the sealant used on the stud times its engagement ratio. When the engagement ratio of the stud is 2.0 or greater, and an ordinary cap or machine screw nut with engagement ratio of about 1.0 is used, Grade A sealant can be used on both.

Table 4—Engagement Ratios*

Screw Material	Minimum Engagement Ratios			
	Grade A or D	Grade C	Grade E	Grade H
Mild steel	1.2	3.1	5.4	12
Medium-carbon steel (heat-treated)	2.1	5.4	9.4	21
Stainless steel (302)	1.5	3.9	6.8	15
Yellow brass (271)	0.8	2.1	3.6	8.0
Soft Aluminum	0.6	1.5	2.7	6.0
Hard Aluminum (2024-t4)	0.8	2.1	3.6	8.0

* Values given are minimum ratios above which fasteners treated with liquid thread-locking compositions shear off.

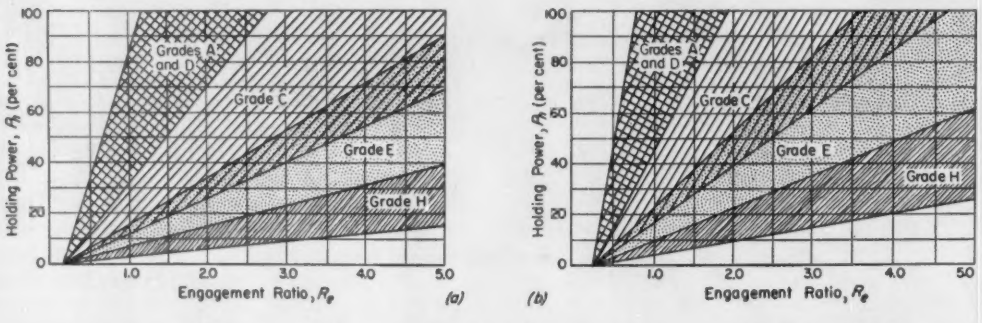

Fig. 4—Holding power of the five grades of liquid compositions on, *a*, mild steel screws and, *b*, aluminum and brass screws. These plots apply to screws of all diameters.

Designing Low-Cost Weldments

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WELDING is a versatile fabrication tool for the competent designer. Unfortunately, engineers familiar with basic design, employing cast or riveted members, may not be familiar with rules for optimum use of welding. This is largely due to the considerably higher rates of thermal change in weldments. Basic metallurgy theories must be treated differently than in furnace applications. With the generally greater degree of boundary fixation in welding, stress analysis must be handled differently than that used in bolted or riveted design. Design of weldments is therefore too frequently thought of as an art, rather than as a science. Generally, there are three common but undesirable approaches to welded design.

COPY DESIGNING: The most prevalent undesirable approach to weldment design is to copy a casting design. Requirements for casting production thus dictate the design for welding. Many examples of this approach are seen, such as splitting a welded frame or bedplate and bolting the members together, merely because a joint is found in similar castings. Another example is the use of stiffening ribs, Fig. 1, in welded design because they are used for castings.

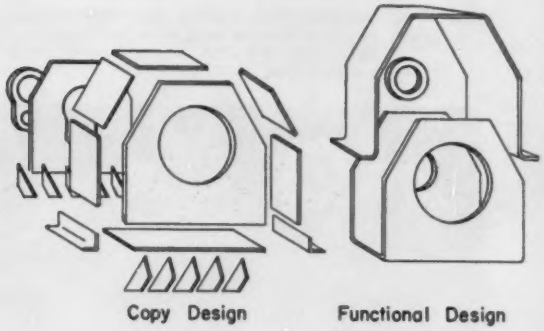


Fig. 1—Proper weldment design results in considerable cost saving over a weldment copied from casting design. Elimination of ribs and utilization of bent plates simplify construction and reduce weight.

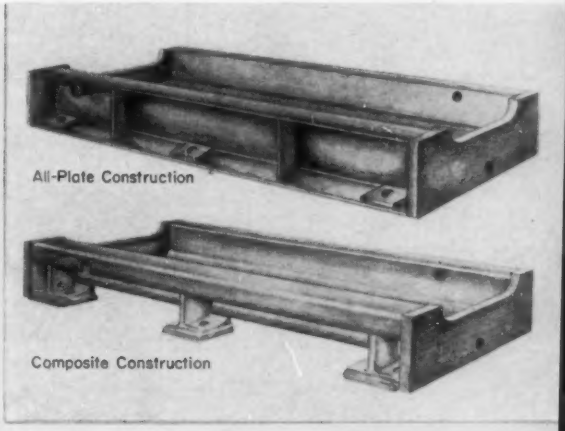


Fig. 2—In weldment design, each member should match its imposed load. Use of cast and bent members for components produces an economical assembly with maximum usefulness.

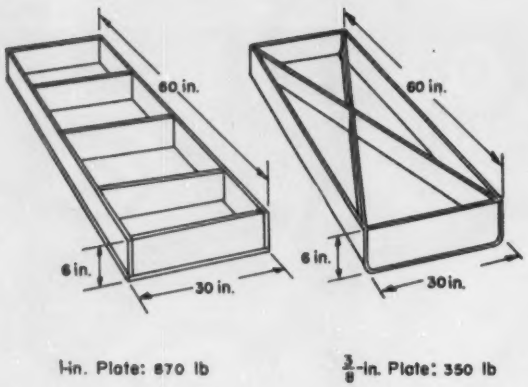


Fig. 3—Rigidity can be imparted in a weldment by careful design. Lowered cost and weight usually accompany careful functional designing.

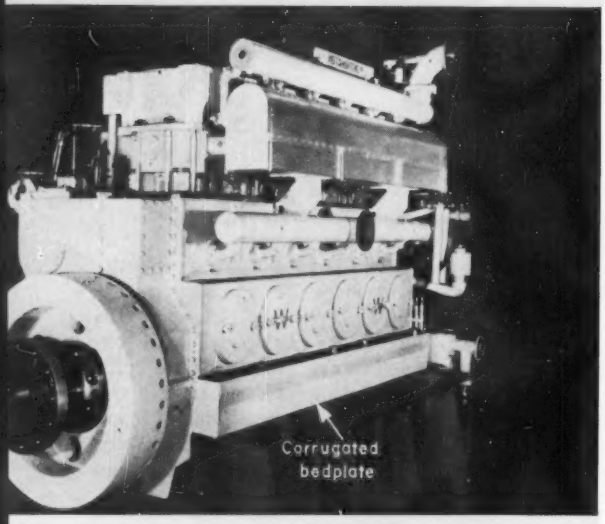


Fig. 4—Corrugated bedplate stiffener absorbs vibration energy and reduces sound level in diesel engine.

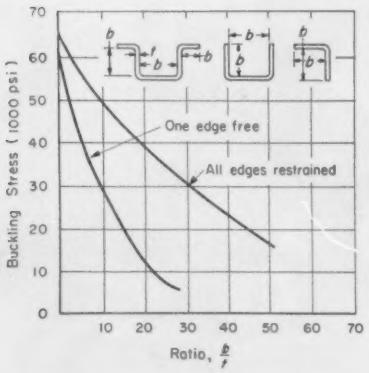


Fig. 5—Curves demonstrate increased load capacity resulting from multiple bends. Values are based upon 2024-T aluminum with 40,000 psi yield point.

In the foundry, a casting may be split because of circumstances concerning molding, patterns, equipment, or pouring problems. Ribs and bosses on castings may be required to overcome hot tears or shrinkage, or for gas control. Large-radius corners and sloping or curved walls in casting design are needed to facilitate withdrawing patterns from molds and to minimize pouring and metallurgical problems. Incorporating such features in weld design by minutely copying good casting practice frequently results in a very expensive weldment.

In many instances, members on a weldment are made excessively heavy merely to duplicate the physical dimensions used with casting. In the casting, the heavy wall may be necessary because of shrinkage or hot-tear problems. In a weldment, distortion problems and tears or cracks due to shrinkage exist, similar to a casting. However, methods of overcoming these difficulties are treated differently. Cracked welds due to shrinkage are overcome by changing the shape of the weld bead, modifying the joint fit-up or occasionally, by increasing the weld size.

In welding, it is not necessary to have uniformity of wall thickness for the various mem-

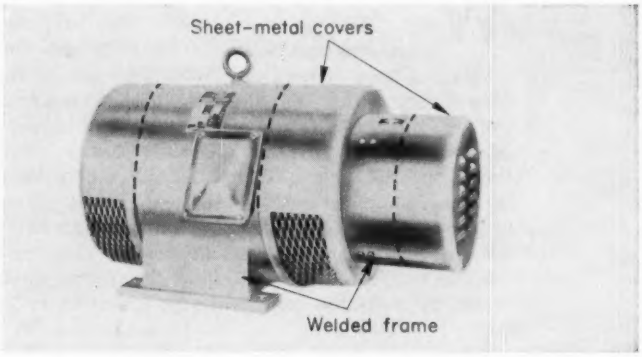
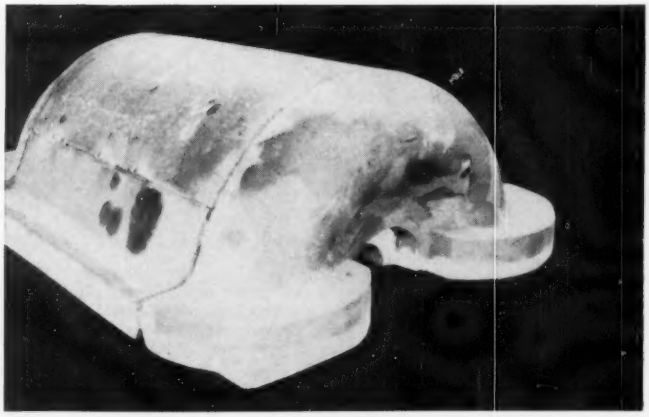


Fig. 6—Lightweight design is achieved by use of sheet-metal covers added to welded structural frame.

Fig. 7—Compressor housing, for pressures to 2000 psi, demonstrates composite construction. Ends and flanges are steel castings; center section is rolled steel plate.



bers, Fig. 2. Each should be designed to take only the loads imposed upon it. A welded joint should be designed only for stress.

Rigidity is the function of the member; the weld is only a medium of fixation, Fig. 3. Consequently, a machine member designed for rigidity may have a stress value of 4000 or 6000 psi. However, the stress on the weld should be calculated on the maximum allowable stress of 15,000 to 18,000 psi.

TOO-LIGHT MEMBERS: The second undesirable approach is attempting to utilize the maximum theoretical value of strength and stiffness of the steel members. This theory results in light structures that may not possess sufficient stability to allow machining or handling in shipment. Machining operations require clamping to prevent chatter and to resist the shearing forces of the cutting tools. To maintain dimensional precision, the fabricated member must resist these forces without excessive distortion.

In addition, light members, inadequately designed, produce diaphragming that may cause unsuitable performance, undesirable noise, and vibrating stresses on the surrounding supporting area. A light diaphragm member is difficult to control because of the many nodes it can vibrate in. However, light-gage materials can be rigidized by corrugations of rectangular, circular or irregular designs to make a marked improvement in load-carrying and stiffness ability, as well as minimizing vibration-control problems, Fig. 4.

Corrugating light materials also improves their ability to carry higher stress levels without buckling or nonelastic distortion, Fig. 5. This reduces the manufacturing cost for material, welding and fabricating. The cost of welding increases as the size of weld is increased, so lighter members do have a strong cost advantage. Another approach to lightweight design is a simple structural design, without regard to appearance. Covers are then added to provide appearance or for protection, Fig. 6.

ALL-WELDED DESIGN: The third undesirable approach is to design a weldment having all elements cut from steel plate and the assembly made up of many flat parts, Fig. 1. This design approach requires considerable labor for fabrication, weld set-up, welding, and cleaning. Further, there may be considerable distortion, requiring excessive straightening or machining allowance. The weld deposit is a costly operation per pound of metal deposited; its use must be minimized.

To design economical weldments, size of welds

Fig. 8—Chrome-moly steel castings are welded together to produce a complex part. Three castings are joined to make up this turbine steam chest.

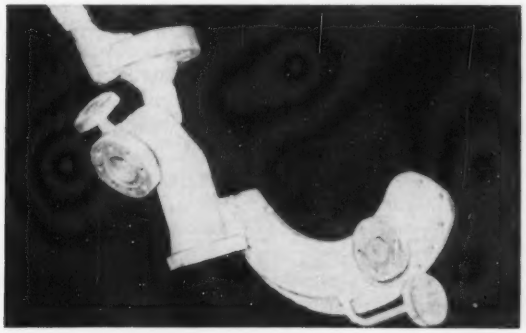


Fig. 9—Welded-impeller design reduced cost, gave better reliability, and improved hydraulic efficiency. Blades have up to 12 per cent chrome content; shrouds are fabricated plate and forgings.

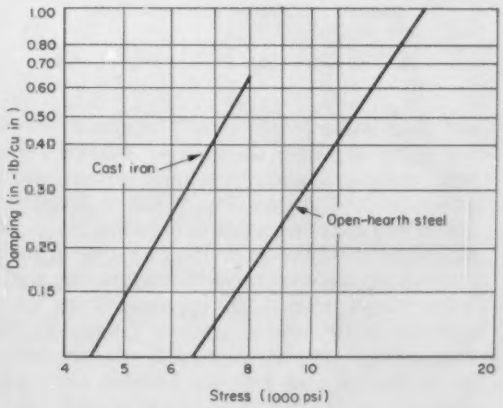


Fig. 10—Chart compares damping of cast iron and steel. Values are based upon cast iron with 25,000-psi ultimate strength, 5000-psi stress, and damping at 0.15 in.-lb per cu in.; steel with 50,000-psi ultimate strength, 10,000-psi stress, damping at 0.36 in.-lb; safety factor for both materials is 5.

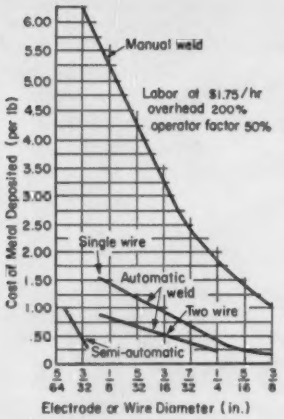


Fig. 11—Cost of welding by various process and wire diameters, per pound of metal deposited.

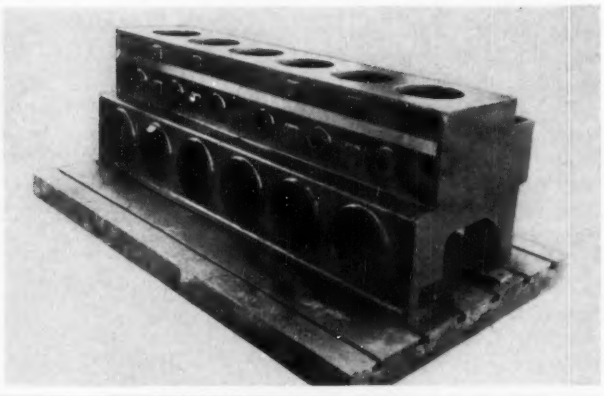


Fig. 13—Diesel-engine frame demonstrates efficient use of bendings, castings, and flat plate.

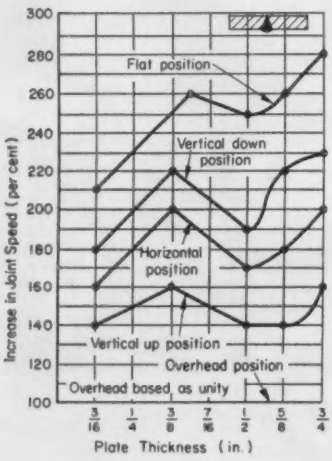


Fig. 12—Design of large units should utilize smaller component weldments. This construction permits more convenient welding, increased joint speed and lower cost.

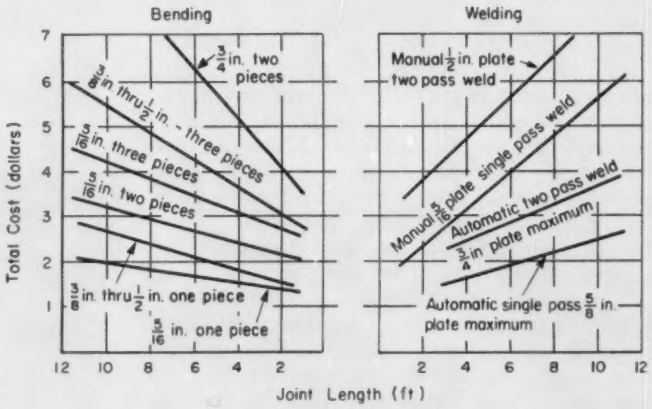

Bending
Welding
Total Cost (dollars)
Joint Length (ft)
Manual 1/2 in. plate two pass weld
Manual 5/16 plate single pass weld
Automatic two pass weld
3/4 in. plate maximum
Automatic single pass 5/8 in. plate maximum

Fig. 14—Charts compare cost of bending and welding. Bending lines are given for determining costs when two or three pieces are bent at once. Welding cost includes shearing or flame cutting edge, but does not include any grinding of finished weld.

and their linear length should be minimized. Consequently, a proper design may incorporate castings, forgings, stampings, and extrusions with plates or steel shapes, Fig. 7 and 8. Welding is a tool where the process can be used that produces the most applicable and economical component for each element of the structure. Consequently, the ultimate design affords an opportunity to use the optimum performance of many processes. These components, properly designed, can be trimmed, fitted, and welded into an integral unit, Fig. 9. Castings, when used, should be of weldable quality, where the analysis and residuals are controlled. In addition, castings should be designed so that they can be readily trimmed to fit into the welded assembly by torch cutting or simple machining.

Vibration: Noise and vibration are quite frequently misinterpreted, especially when comparing cast-iron with welded steel plate, Fig. 10. It is generally understood that cast iron, due to its structure, absorbs energy more efficiently than steel. However, the total energy absorbed in a dynamic application is a function of the safe stress which can be applied. Designing for the same stress, with a safety factor of five, a comparison of cast iron and steel indicates an increase in damping value for steel of 140 per cent. The importance of this point is that the designer must be certain that the steel structure is not overdesigned to produce very low stress levels.

Welding Costs: The actual welding operation is costly on a per-pound basis. Therefore, concentrated effort should be given to minimize its use. There are many factors that influence weld-

ing cost. Variation in cost can be from $6.50 to $0.25 per pound. Among factors affecting welding cost are the type of welding process, size of wire or electrode, Fig. 11, welding position, Fig. 12, and operating factor. For instance, with 3/32-in. manual electrode, cost of weld deposit is about $6 per pound. With the same size wire and with the semiautomatic-submerged method, the cost is $0.42 per pound. Consequently, by making the design suitable for semiautomatic weld application, a substantial cost reduction can be realized. The important factors are elimination of corner joints and employment of subassemblies that can be produced with downhand or horizontal welding positions. Instead of corner joints commonly used for manual welding, tee joints produced by fillet welding should be used. Half-open corner joints on material over 7/8-in. thick can be used if a sufficient ledge is provided to support flux.

Eliminating corner welds and employing a design where the electrode size can be increased will also produce substantial cost reductions. Typical is an increase from 5/32-in. diam electrode at $4.25 per pound of metal deposited to 1/4-in. diam at $1.75 per pound of deposit. In addition to higher deposition rate, larger electrodes will produce less distortion in single-pass welding than the multiple-pass welding required with small electrodes.

Bending: Considerable use of bent components will result in savings over welding of many small pieces, Fig. 13. Bending, where feasible, not only decreases cost by minimizing welding, but also improves appearance and decreases fabrication cost. Generally, bent external corners produce an attractive appearance because of the highlights they reflect. In many instances, the first visual impression of fabrication by welding can be completely eliminated. Bending also minimizes the number of pieces that must be fabricated. On a 100-lb weldment, fabrication cost is increased 5 cents per pound by increasing the number of pieces to produce the weldment from six to twelve, Fig. 14.

Producing joints by bending is considerably more economical than cutting individual plates and welding the joints. For instance, from Fig. 14, the cost of producing two bends 2-ft long in 5/16-in. material is only $2.10; for manual single-pass welding the cost of two joints is $4.60. The bending cost takes advantage of bending two parts at once; the welding cost does not include any weld grinding but does include shearing cost.

It is important for the designer to specify a bending radius that does not require special dies. A properly equipped fabrication shop will have a press brake with dies suitable for the range of material thicknesses fabricated. The female-die opening should be eight times the average material thickness used. This die opening will allow bending material from 1/4 to 2 times the average thickness. In this range, the inside radius will be nominally 5/32 of the die opening with standard air bending. Consequently, on a 4-in. female die, the nominal inside radius will be 5/8 in., regardless of material thickness. It is important for the designer to allow a minimum straight portion on the plate equal to one-half the die opening. For economy in job-shop production, the designer should use one die combination throughout a complete design.

Pointers for Proper Design: Easy fit-up of parts can be obtained by using maximum tolerances on the fabricated parts as well as on the final assembly. Flexible, U-shaped members are

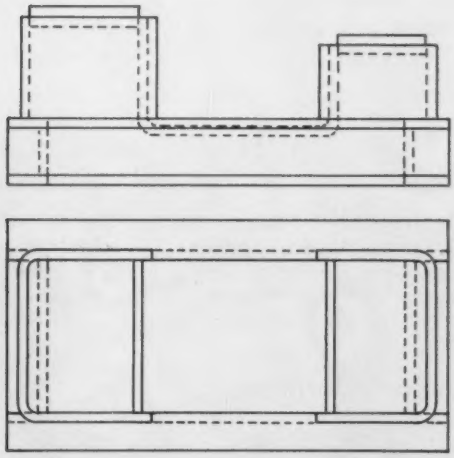


Fig. 15—Pump bedplate demonstrates designing for easy weld fit-up. Center bent part establishes width and the two vertical end members are sprung to fit.

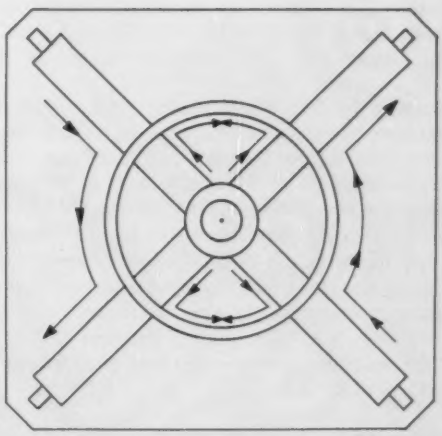


Fig. 16—Proper welding sequence reduces distortion. In this positioner top, final distortion of part, about 2-ft wide, was reduced from 5/8 to 1/8 in. by planning weld sequence.

easily sprung to fit, Fig. 15. Ample means should be provided in joints for sufficient thermal capacity to permit use of large electrodes or high thermal-capacity processes.

In welding, the major welding between the stiffest members of the structure is done first, Fig. 16. This produces minimum distortion. Vertical welds are then made from the outside surface to the major longitudinal welds. Dimensions between any pads are then checked and, if necessary, the tack welds broken and the pads realigned and welded. This procedure allows a minimum amount of machining.

There are many facets to good weldment design. Material cost can be 40 to 70 per cent of the cost of the weldment. Conservation of steel not only has a marked effect on weldment cost but also decreases welding and fabrication cost. Distortion is another important factor in minimizing stress concentrations and consequent straightening costs. Metallurgy is an important consideration, especially in dynamic applications. The mere presence of a structural change can produce a sizable change in final properties. The important point for the designer is to design for economic production, environment and final use.

Tips and Techniques

Mathematical Short Cuts

Squaring Numbers Mentally: With a little practice, most numbers can be squared mentally by a simple process. The number to be squared is subtracted from the nearest multiple of ten, or the nearest multiple is subtracted from the number, depending upon which will produce the lesser difference. When the number is subtracted from a larger multiple, the difference produced is then subtracted from the original number. This remainder is multiplied by the multiple used. To this figure is added the square of the first difference between the original number and the multiple. The answer is the square of the number.

For instance, to square 27, the nearest multiple of ten is 30; $30 - 27 = 3$; $27 - 3 = 24$; $24 \times 30 = 720$; $720 + 9 = 729$, the square of 27.

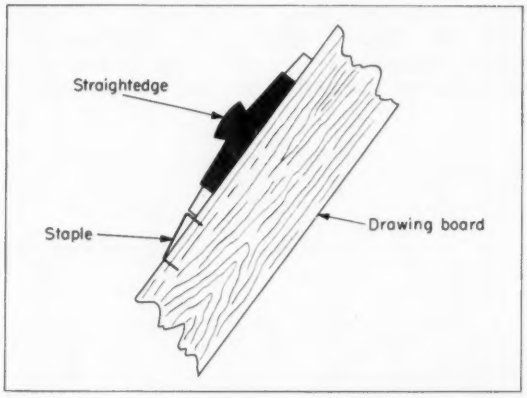
If the nearest multiple of ten is less then the original number, the difference is added to the number, but the square of the difference is still added later. For instance, to square 23, the nearest multiple of ten is 20; $23 - 20 = 3$; $23 + 3 = 26$; $26 \times 20 = 520$; $520 + 9 = 529$, the square of 23.

Multiplying by 11: When multiplying any two-digit number by 11, add the two digits together and place this figure between the two numbers. Thus, to multiply 35×11, add $3 + 5 = 8$; place 8 between the two digits: $35 \times 11 = 385$. If the sum of the two digits exceeds 10, the last figure of the two digits in the sum is placed between the two original numbers and the first number of the final figure is increased by one. Thus, to multiply 89×11, $8 + 9 = 17$; place 7 between the two digits, 879, and then increase the first digit by one: $89 \times 11 = 979$.

Checking for Multiples of 3: To see if a number may be a multiple of 3, 6, or 9, add the individual digits in the number. If the sum of the digits is a multiple of 3 or 9, the original number is also. If the sum is a multiple of 3 and is an even number, the original number is also a multiple of 6. Thus, the number 584,172 has a sum of its individual digits of 27. This sum is a multiple of both 3 and 9, so the original number is also. Since 27 is not a multiple of 6, neither is the original number. —A. DENNISTOUN-WOOD, *Ngaio, Wellington, New Zealand.*

Keeping Straightedge on Board

A simple way of holding a parallel-bar straightedge on the board when it is at a steep angle is to drive a staple (about ½-in. size) vertically



into the board perpendicular to the rule. Then lift the top leg with a knife. The raised leg forms a stop against which the bar rests. — JERRY L. BROWN, *National Tank Co., Tulsa, Okla.*

Pressure Switches

In "How to Select and Apply Pressure Switches" by William B. Wallace Jr., Aug. 22 issue, pp. 106 to 114, all illustrations of actual switches were supplied by Barksdale Valves, Los Angeles. Inadvertently, credit to Barksdale was omitted from the article.

Design methods of

Cooling Electronic Equipment

By ALFRED S. GUTMAN
Engineering Specialist
Sylvania Electric Products Inc.
Waltham, Mass.

MOST of the electric power used to operate present day electronic equipment is converted into unwanted heat; only a small part of the power is converted into useful energy. Naturally, generation of this unwanted heat leads to an undesirable temperature rise in the equipment. Magnitude of the temperature rise depends on both the amount of heat dissipated by the equipment and effectiveness of the heat transfer from the equipment to its environment.

▸ Modes of Heat Dissipation

There are three modes of heat transfer: convection, radiation, and conduction. Convection plays the major role in cooling electronic equipment. The temperature differential between electronic parts and their environment is usually small and, since radiated power follows a fourth power law, the cooling effect of radiation is negligible. A notable exception to this is within vacuum tubes, where radiation is an important factor. However, this discussion is concerned with heat transfer

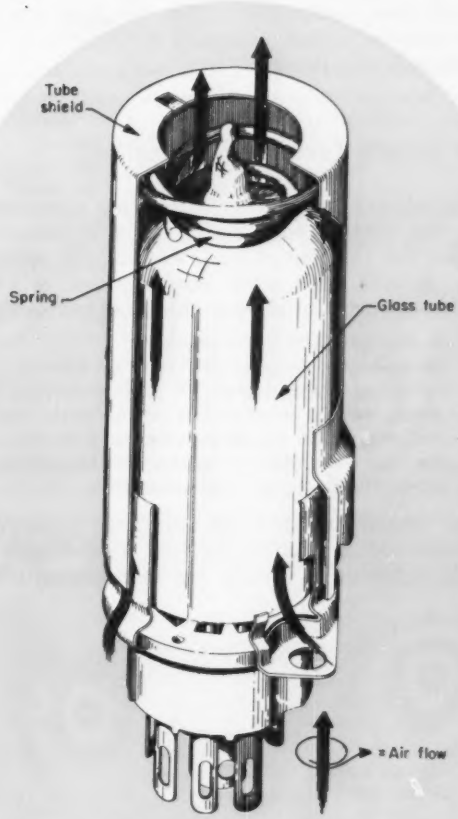


Fig. 1—Cutaway of typical tube-shield showing direction of air flow which cools tube.

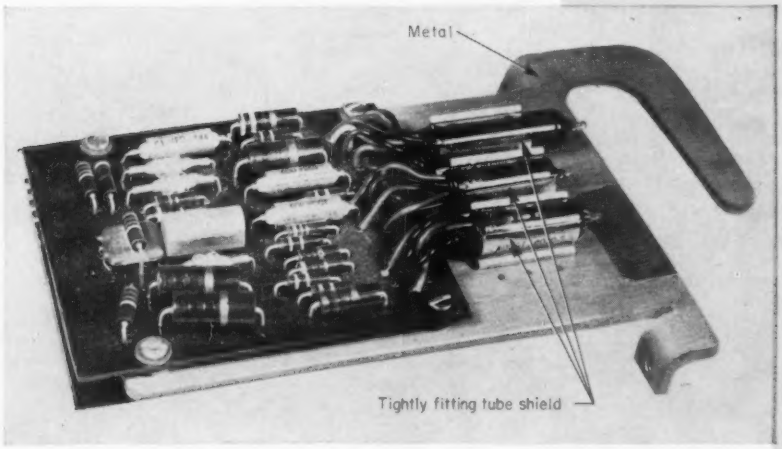


Fig. 2—Computer tubes cooled by both conduction and natural convection.

from electronic components to their environments and not with heat transfer within components.

Conductive heat transfer takes place through metals and is often used to transfer heat from a concentrated source, for example, a vacuum tube, to a large area that can be more effectively cooled by convection. In addition to being dissipated by radiation as mentioned previously, the heat generated within vacuum tubes is also transferred by conduction, through the metallic tube leads. Excessive heating of these leads can result in softening of the glass, electrolysis within the glass between the tube leads, and eventually in porosity of the glass and tube failure.

Natural Convection Cooling

In ordinary electronic equipment like a television receiver, little special design effort is necessary to aid the transfer of heat. The metallic shields, Fig. 1, used with some vacuum tubes in such equipment actually serve a three-fold purpose of:

1. Acting as electrostatic shields.
2. Mechanically securing the tube to its socket by means of a spring that is part of the shield.
3. Aiding natural convection by virtue of the fact that they leave an air space around the tube; the warm air rises and passes out through the top of the shield by a chimney effect.

In specialized electronic equipment, however, miniaturization is often employed. Heat density of such equipment is greater and therefore an effective means of transferring the heat must be devised. A common technique used to transfer heat from miniaturized equipment is to clamp vacuum tubes in closely fitting electronic shields; the shields are in turn attached to a larger surface, which dissipates the heat. As shown in a computer etched-circuit package in Fig. 2, tubes can be clamped directly to a large metallic surface. This large surface results in more effective heat transfer to the air by convection.

Direct Forced Cooling

When miniaturized electronic equipment is for airborne applications, for example, the natural convection process is not sufficient to cool the equipment. At the higher altitudes, convection is much less effective because of the decreased heat capacity of the lower density air. Additional cooling is usually provided by a fan or blower. Ordinary blowers deliver a constant volume flow, and therefore their mass flow is reduced at lower air density. Effective utilization of a blower requires that it deliver the same mass of air at all altitudes. The mass of air delivered by the fan can be varied by adjusting, with altitude, either its speed or the pitch of its blades. If the blades of the fan are spring-loaded, their pitch can be made dependent on the air pressure. In some cases, the air pressure on the rotating blades is sufficient to accomplish the adjustment; in other cases the adjusting forces are created with the aid of an evacuated bellows.

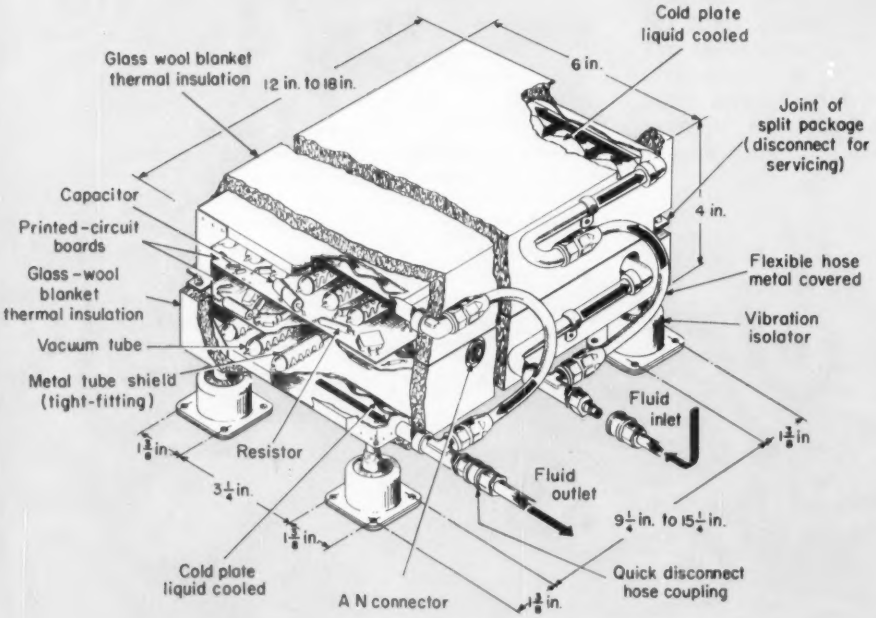


Fig. 3 — Electronic package designed with a liquid-cooled cold plate.

Indirect Forced Cooling

To create a large surface area for the transfer of heat from the electronic equipment to the forced cooling air, the metallic container of the package is built with double walls and also serves as a heat exchanger. Tightly fitting tube shields are used to clamp the tubes to the walls, thus effectively conducting the heat from the tubes to the metallic walls, which are called cold plates. These cold plates can be internally cooled either by air flow or liquid cooling. Since the cold plate provides not only the necessary area for heat transfer but also gives structural support to the enclosed equipment, its weight cannot be charged against the cooling equipment alone. With skillful mechanical design, equipment cooled in this manner need not weigh more than equipment cooled by direct air flow.

The method of liquid cooling the cold plates has the advantage of avoiding direct contact between the cooling liquid and the electronic components, Fig. 3. Such direct contact must be avoided unless the liquid is a good electrical insulator. Since liquids have high dielectric constants, they increase electrical capacity in high-frequency applications between parts, which is undesirable. An additional advantage of the type of liquid cooling system illustrated is that the equipment can be serviced without draining the liquid.

Until recently, the use of cold plates represented the most advanced and sophisticated technique for cooling airborne electronic equipment. It has a number of advantages and drawbacks. The advantages are:

1. The cooling medium does not come into direct contact with the electronic components.
2. Surface area for heat transfer to the cooling medium can be designed as large as desired.

The disadvantages are:

1. Cold plates may add weight to the equipment.
2. Several temperature gradients are involved between (a) the tube and the tube shield, (b) the tube shield and the cold plate, and (c) the cold plate and the cooling medium. The temperature gradients within the tube shield and within the cold plate must also be considered.
3. The package is essentially run at uniform temperatures.

Skillful design of a cold-plate system will reduce the effect of the first two disadvantages to the extent that they become insignificant. If a sufficient quantity of cooling air is available, the third disadvantage is not significant either. However, where economy of cooling-air consumption is of importance, it is desirable to carry away a maximum amount of heat with each cubic foot of air. This makes it necessary to exhaust the cooling air at the highest possible temperature. To accomplish this, it is desirable to cool the components in the

Fig. 4—Still-air temperature gradients on a No. 6111 subminiature tube which dissipated 3.97 w. of power.

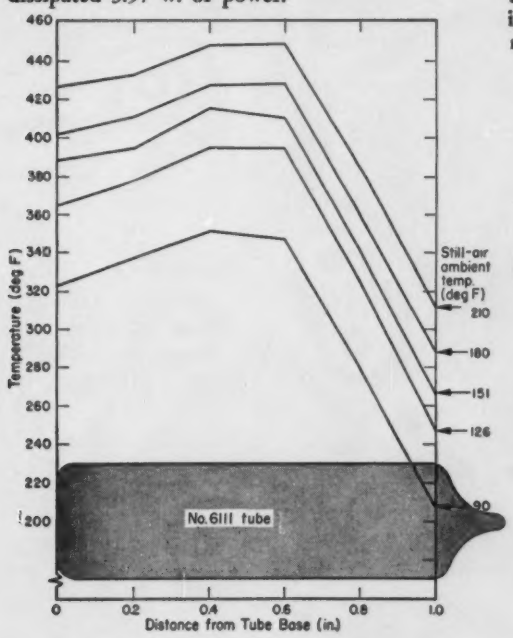
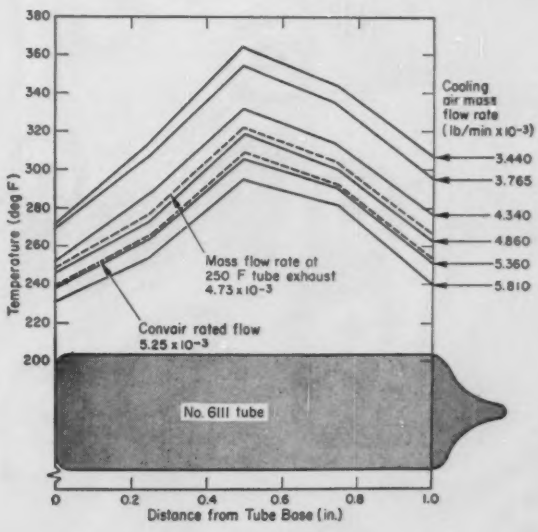


Fig. 5—Temperature gradients on a No. 6111 subminiature tube with cooling air flow. Inlet air conditions; dry-bulb temp, 69F; wet-bulb temp, 56F; barometric pressure, 29.42 in. Hg; tube dissipation, 4.02 w; orifice diam, 0.0694-in.; annular spacing, 0.029-in.



order of their maximum allowable operating temperatures. This means that components with high allowable operating temperatures would be cooled last.

Application and Design Data

The availability of air for the cooling of electronic equipment in subsonic aircraft is usually not a problem. With the advent of supersonic aircraft, missiles, and satellites, however, cooling of electronic equipment presents several new problems. Since satellites operate beyond the atmosphere, air cooling is not feasible and cooling must be accomplished by radiation. On the other hand, missiles usually have a flight of short duration; if the missile has a large heat capacity and can be cooled before launching, excessive temperature rise during the flight can be avoided.

In long-range supersonic aircraft, the solution of the cooling problem is more difficult. Approximate skin temperature T_s of a supersonic aircraft in

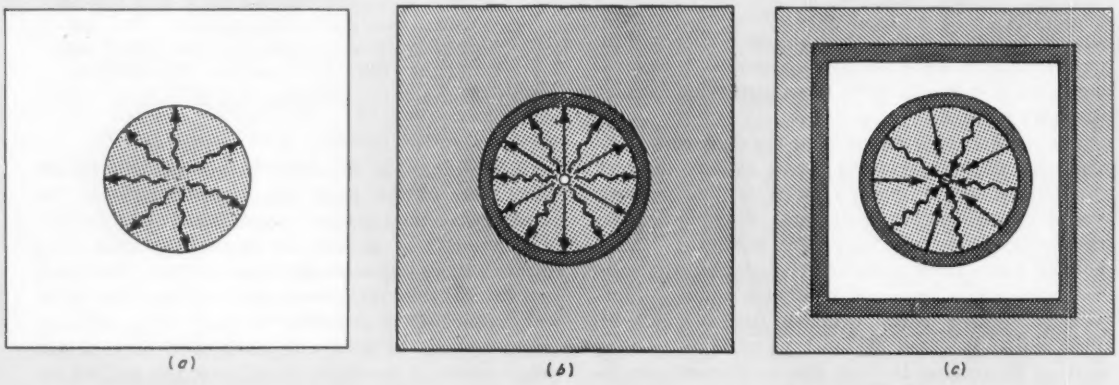


Fig. 6—Heat transfer in electronic equipment in cool environment *a*, hot environment *b*, and refrigerated environment *c*.

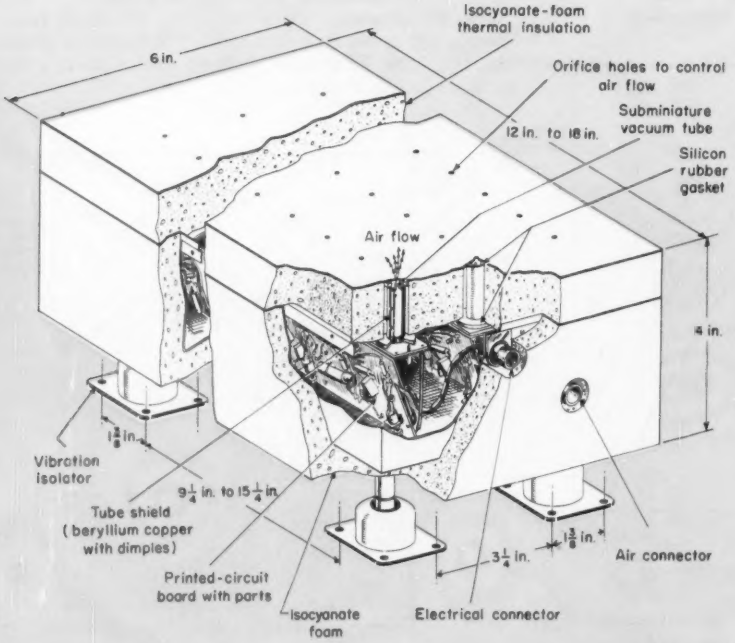


Fig. 7—Typical design in an air-cooled electronic package.

degrees Rankine is given by the formula $T_s = T_a (1 + 0.2 M^2)$ where T_a = ambient temperature in degrees Rankine; and M = Mach number. For an assumed ambient temperature of −60 F (400 R), this formula yields the following results:

Mach. No.	Skin Temperature T_s (deg F)
2	260
3	660

Design Components: Present-day electronic parts are not capable of operating reliably at temperatures listed in the preceding table, and equipment must be cooled so that the parts are not destroyed by the heat. Most commercial electronic parts are available with an upper temperature limit of 185 F; many are available with an upper temperature limit of 250 F; but parts must and are being developed that will be capable of operating reliably in supersonic aircraft. Each type of electronic component is available in many different combinations of parameters. For instance, capacitors are available in 50 capacitance ratings, 10 voltage ratings, 2 tolerances, and 4 physical configurations, giving about 4000 different capacitors. It is therefore obvious that it will be some time before all types of all components are available at the higher temperature ratings.

Since present temperature limits of most electronic parts are below supersonic aircraft skin temperatures, their cooling must be accomplished by refrigeration systems. Such systems are costly in weight and power consumption. To keep a pilot alive in a Mach 3 aircraft requires as much fuel and power as is required for the propulsion of the aircraft. Economic use of the refrigeration equipment in supersonic aircraft is therefore extremely important.

In designing such a cooling system, the designer must take advantage not only of the different temperature ratings of the various electronic parts but also of the temperature differentials that may exist in one part. Fig. 4 shows the temperature distribution on a 6111 subminiature electron tube in still air at sea level. For reliable operation, the base of this tube must be kept at a temperature less than 300 F. By using a tube shield, which gives a 1/32-inch annulus around the glass envelope of the tube, and blowing air through the annulus, the temperature of the tube can be lowered with a small flow of air. The effect of this technique on the 6111 tube is shown in Fig. 5.

Thermal Insulation Design: When taking ad-

Fig. 8—Packaging-design details in a parallel airflow cooling system. Tubes and rubber sleeves are positioned down in holes in foam-plastic block.

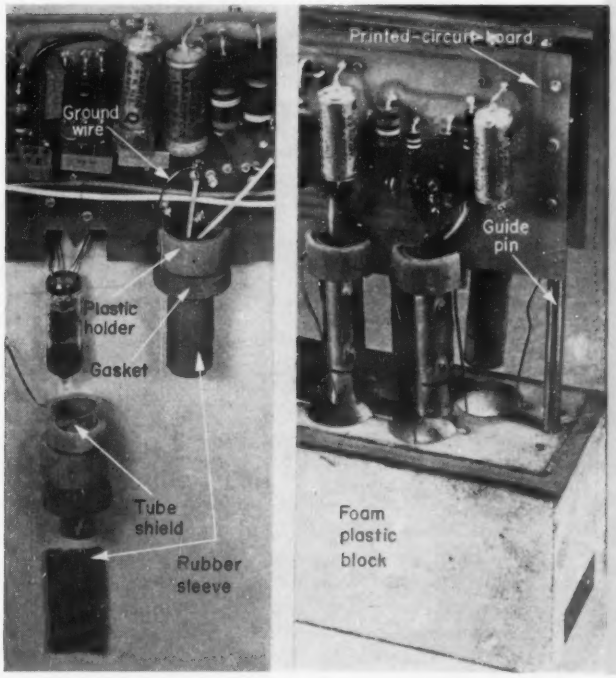
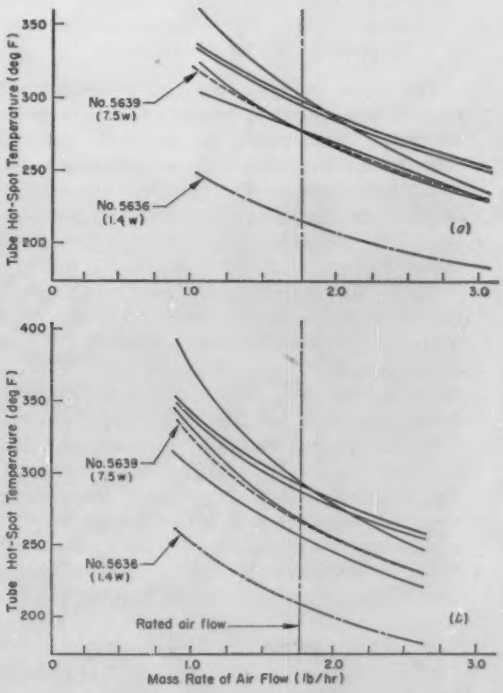


Fig. 9—Plots of hot-spot tube temperatures versus mass rate of air flow in the electronic package shown in Fig. 8 for seven subminiature tubes. Inlet air pressure in *a* was 14.7 psia and inlet air pressure in *b* was 5.35 psia. All tubes were No. 5840 unless otherwise designated. The 5840 tubes dissipated 2.5 w.



vantage of the temperature differentials within the equipment, the designer must also consider the ambient temperature conditions under which the equipment must operate. Efficiency of the cooling technique can be greatly increased by the proper use of thermal insulation.

To simplify the explanation, assume that the electronic equipment is in a spherical container; no thermal insulation is required if the container temperature is higher than that of the environment, Fig. 6*a*. However, if the container is operated in an ambient temperature that is higher than the container temperature, as would be the case in a supersonic aircraft, thermal insulation and container cooling are required, Fig. 6*b*.

If the electronic package is placed in the air-conditioned cabin of the aircraft, it is not desirable to transfer the heat of the package into the cabin; this would increase the cooling requirements for the cabin. Since it is possible to cool the equipment with air that is too hot for human comfort, it is economical to use cabin exhaust air for equipment cooling. This technique requires extensive container thermal insulation, Figs. 6*c* and 7.

Parallel Air-Flow Design: The basic requirements for the economic cooling of electronic equipment in high-temperature environments, such as encountered in supersonic aircraft, are:

1. Cool the parts having low permissible temperatures first and those having high permissible temperatures last, thus exhausting the cooling medium (air) at a high temperature.
2. Place thermal insulation between electronic parts of different temperatures and between the package and its environment.

The basic requirements are somewhat difficult to put into practice because the arrangement of electronic components is dictated primarily by circuit considerations, such as lead length and electrical interference. Furthermore, insulating high-temperature parts increases their operating temperatures, unless an effective cooling system is contained within the thermal insulation.

These design problems have been solved by a new cooling technique* developed by the Electronic Systems Division of Sylvania Electric Products Inc. at Waltham, Mass. and Buffalo, N. Y. The technique is illustrated in Fig. 8, which shows electron tubes being cooled separately by a parallel air flow. Unlike a series flow arrangement, in which the parts should be located according to their temperature ratings (frequently disagreeing with electrical requirements), this arrangement allows complete freedom in the placement of components. The air flow through each parallel channel is controlled by metering orifices; parallel air flow has the additional advantage of a low pressure drop. The cooling system has been built inside the plastic thermal insulation. To cool the tubes effectively by forced convection, it is desirable to have an annular air space around the tube of about 1/32-inch. However, the tolerance of the glass envelope is larger than 1/32-inch. Therefore, to make a 1/32-inch annulus, a flexible metallic shield that adjusts to the diameter of the enclosed tube has to be used. This shield is dimpled; size of the dimples determines the size of the annular air space. Packaging details are shown in Fig. 8.

The performance of seven subminiature tubes in such a package design is plotted in Fig. 9. Inlet air temperature was 70 F, and the hot spots of the seven tubes at sea level and at 25,000 feet (5.35 psia) are recorded at various air-flow rates. At the same time, the temperature of other electronic parts was recorded. Low-voltage parts were at less than 110 F and ½-watt resistors were at about 185 F, which are acceptable temperatures.

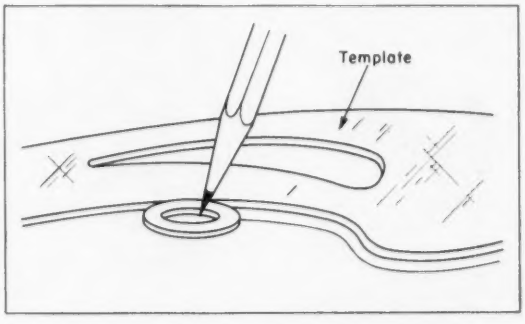
Using this technique, it has been possible to design and build compact electronic packages with exhaust-air temperatures as high as 250 F while temperatures of all electronic parts within the equipment are low enough to ensure equipment-operation reliability. Capacitor temperatures are kept at or near inlet air temperature; resistor temperatures are kept below 185 F; electron-tube base and hot-spot temperatures are kept at or below approximately 300 F and 330 F, respectively. Thus, the technique combines the reliability of the electronic equipment operation with cooling-air economy and allows the electronic design engineer complete freedom in the placement of components.

*Another version of this cooling technique was described in the September 6, 1956, issue of MACHINE DESIGN on page 81.

Tips and Techniques

Tracing Parallel Curves

When drawing parallel curved lines, an assortment of flat washers is very useful. As shown in the sketch, a washer of proper width is rolled

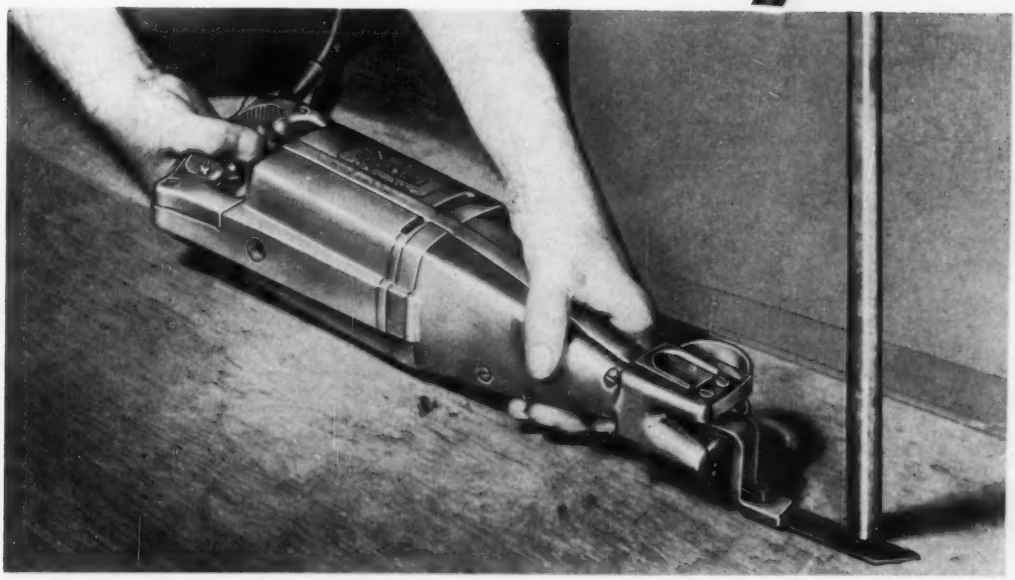


along the edge of a French curve or template by the pencil point. By selecting washers of various sizes, a series of lines can be drawn to any required spacing.—ARNE BENSON, *Sanders Associates Inc., Nashua, N. H.*

Tapered Housing Design Permits Flush-to-Surface Sawing

New electric reciprocating saw manufactured by the R. C. S. Tool Corp., Bloomington, Ill., is designed to cut metallic or nonmetallic materials flush with any surface. Flush-to-surface sawing is easily accomplished because of the novel tapered housing construction and a Z-shaped saw-holder extension.

Designated as the model 250 Super Saw, this unit has an overall length of 16 in., less sawblade, and weighs 8 lb. It is equipped with a ½-hp, 5-amp motor, and delivers 2500 strokes per minute.

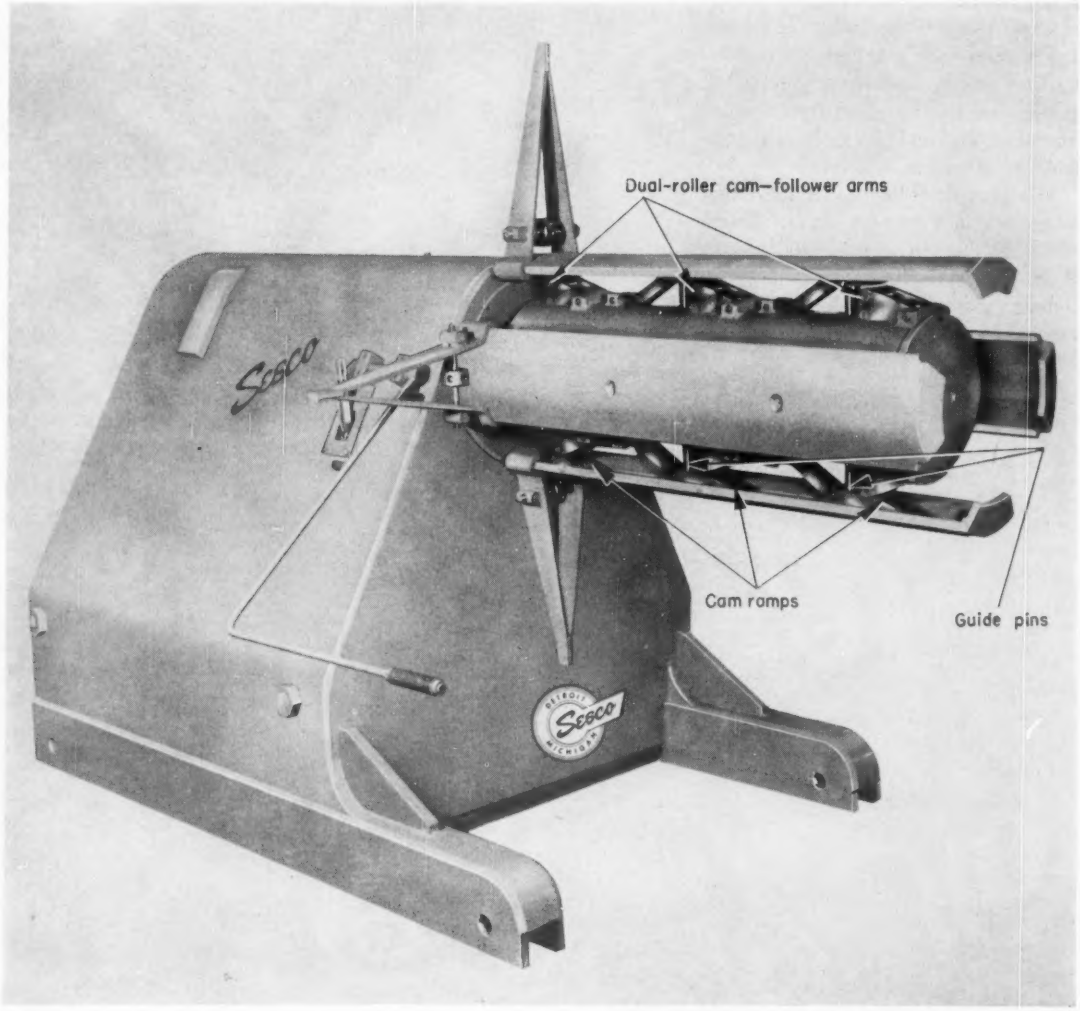


Arbor Diameter Changed with Motor-Driven Cam-Linkage System

Expansible-arbor centering reel, designed by Sesco Inc., handles rolls of paper in widths to 5 ft, diameters up to 6 ft and weights up to 15 tons. The adjustable arbor-diameter design allows for 6-in. variations of inside coil diameters.

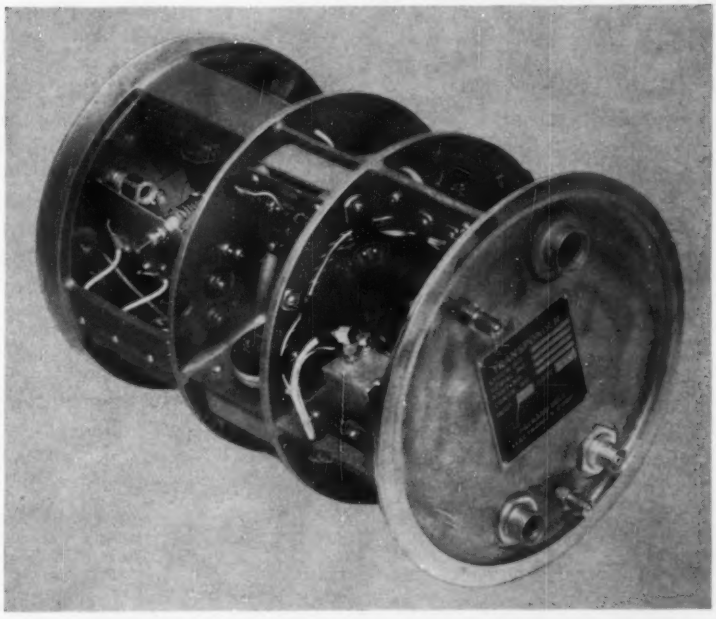
The arbor is expanded or retracted through an electric-motor drive arrangement which simultaneously moves twelve heavy roller arms through arcs that are parallel to reel axis. This action causes one or both rollers in each arm to roll down their respective cam ramps which are mounted on the inside of the reel jaws. Geometry of the cam-roller-linkage system forces the jaws to expand as the rollers move down the ramps in the centering reel.

Proper relationship of expander jaws to the main spindle is maintained by two heavy guide pins on each jaw member.



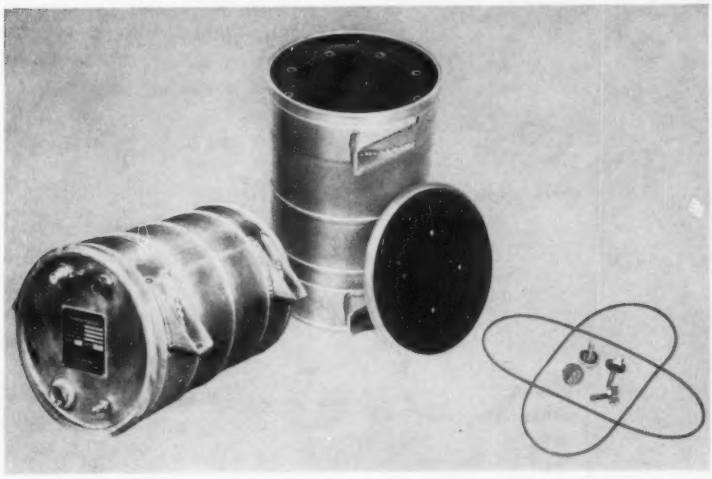
Cast-Aluminum Electronic Chassis Withstands Missile Flight Requirements

A high-powered doppler transponder, designed by Packard-Bell Electronics Corp., meets the severe environmental requirements encountered in missile service. Main function of the electronic unit is to broadcast a signal upon the receipt of a signal in the vhf range at twice the frequency of the received signal.



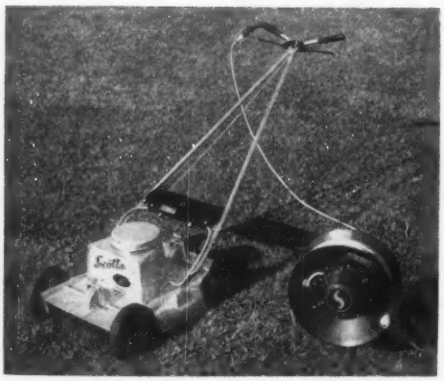
As reported by M. H. Murphy, chief electronics engineer, and P. Creutz, senior electronics engineer, at the National Convention on Military Electronics held at Washington, D. C., in June, the electronic chassis and components had to be constructed to meet the following service conditions: 1. Shock pulse of 30 g amplitude of 11 millisec duration. 2. Sinusoidal vibration of ½-in. double amplitude from 2 to 17.8 cps and 8 g from 17.8 to 2000 cps. 3. A 12 g acceleration. 4. Internal temperatures up to 125 C. 5. Altitude up to 150,000 ft. To withstand this environment, the main chassis frame was made of a cast aluminum alloy because this metal was considered the best compromise between mechanical rigidity and heat conductivity. The frame design consists of a cylindrical core with radially extending circular-disc platforms and longitudinal interconnecting ribs for reinforcement.

Main frame and subchassis are gold plated in all areas where solderability for reliable electrical bonding is required.



Cylindrical housing for electronic chassis assembly is also an aluminum-alloy casting. The front pressure plate is integrally cast with housing frame, and a circular lid is bolted to the other end of main frame.

Rack-and-Pinion Adjusters



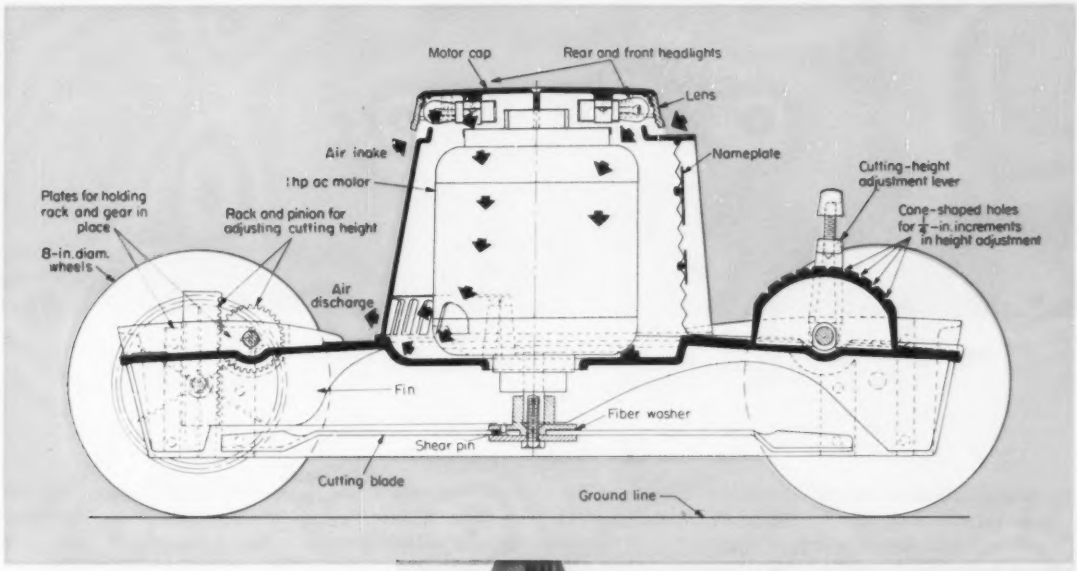
New rotary mower is designed to cut grass over a wide range of cutting heights. Outstanding mechanical and electrical design features minimize danger to operator and bystanders. Developed by O. M. Scott and Sons Co., the electrically driven machine is powered by a Westinghouse 1-hp, 115-v ac motor operating at 1750 rpm. Electric power is supplied through a 125-ft, three-wire cord wound on a reel assembly, which fits into a holder driven into the ground. The third wire permits grounding the machine.

Handle is designed to swing over top of machine, permitting operator to push machine in the opposite direction without turning it around. This keeps the electric cord on the same side.

Rack-and-pinion height-adjustment mechanisms are employed to change mower height over a range of ¾ to 2¾ in. To reset cutting height a locking screw on each adjuster is backed off. This action permits moving an adjustment lever either forward or backward, turning a pair of gears which lower or raise a pair of gear racks. Two height-adjustment assemblies are utilized in the design—one for the front wheels and one for the back wheels.

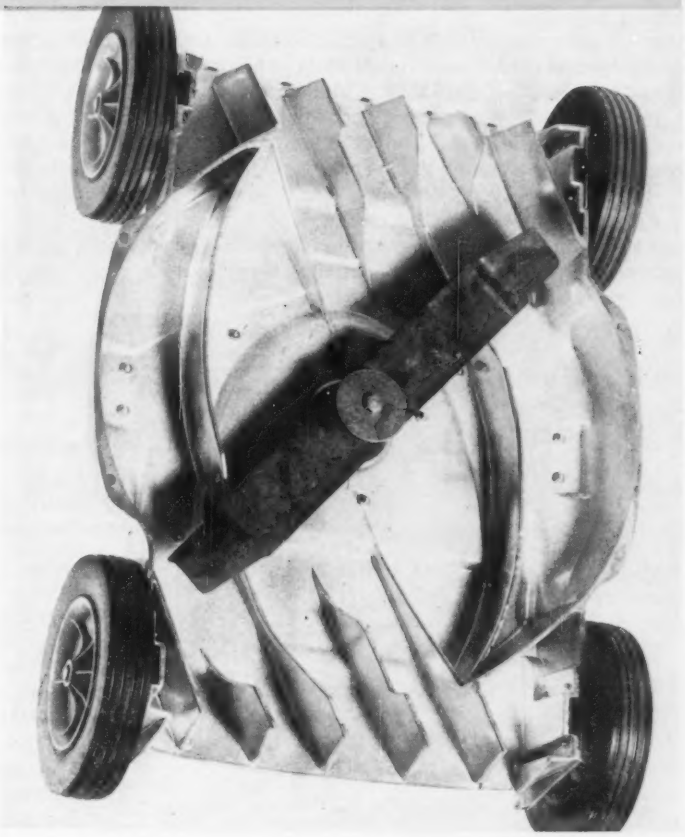
A combination regenerative-dynamic braking system stops blade in about 1½ sec on turf and 3 sec in the clear. So-called "dead man" control levers on the mower handle operate circuitry which stops the blade. An extra condenser is incorporated in the circuit that applies a reverse braking effect on the motor when power is cut off.

Change Mower Cutting Height

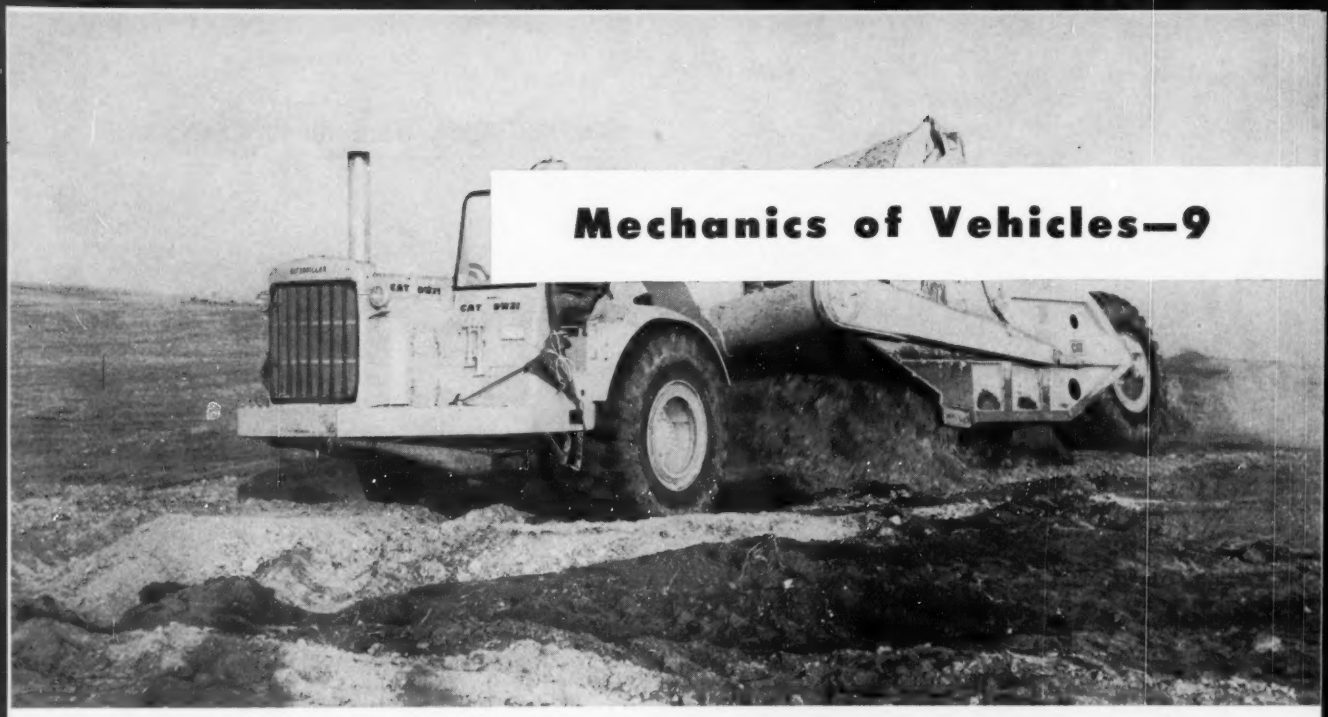


Built-in headlights mounted in front and back of motor-housing cover cap permit night cutting in either direction. Lamps are standard, low-voltage automotive types with a 21-candle power light output.

Air for cooling the motor is drawn in from the top of housing and discharged at the bottom. Fan action of mower blade also cools the mower frame which absorbs some motor heat.



Aluminum-vane safeguard design in mower body helps protect feet and hands from contact with the high-speed blade. The vanes also reduce force of ejection of stones or bits of metal propelled by the blade, which is 19 in. long and revolves at 1750 rpm.



Mechanics of Vehicles—9

MAXIMUM transferable tractive force—as determined by the nature of the wheel-ground connection—sets a fundamental limit to vehicle performance. It follows, therefore, that the type of drive employed in the vehicle—front, rear, or four-wheel—influences its ultimate capacity for speed, acceleration, gradability, and drawbar pull.

In this article, the performance-limit concept is reviewed, and the relative advantages of the three common drive systems are compared.

Equation of Motion: Performance of a vehicle can be predicted from its equation of motion. When interpreted for a moving vehicle, the energy theorem gives the differential expression

$$dE = (P - \Sigma R)\, ds \tag{132}$$

where P is tractive force and $\Sigma R = R_r + R_a + R_g + D$. When both rotating and translating vehicle masses are considered,

$$E = \frac{mv^2}{2} + \sum \frac{I\omega^2}{2} \tag{133}$$

As detailed in Part 6 (Aug. 8, 1957), this expression is differentiated and the following substitutions are made:

$$\omega = \omega_d \zeta$$

$$\omega_d = \frac{v}{r}$$

$$m\gamma = m + \frac{\Sigma I \zeta^2}{r^2}$$

In these equations, ω_d is the angular speed of the driving wheels, ζ is the reduction ratio between each rotating part and the driving axle and γ is the factor giving the equivalent inertial effect of rotating parts (Part 6). After these operations are performed, the resulting expression for dE is

$$dE = mv\,dv + \Sigma I\omega\, d\omega$$

$$= v\,dv \left(m + \frac{\Sigma I \zeta^2}{r^2} \right)$$

$$= v m \gamma\, dv \tag{135}$$

Since $v = ds/dt$, and $a = dv/dt$, combining Equations 132 and 135 gives

$$am\gamma = P - (R_r + R_a + R_g + D) \tag{136}$$

which is the general equation of vehicle motion.

Performance Limits

Calculation of vehicle performance limits is based on the fundamental relation

$$P_{max} = W_d \mu \tag{137}$$

This equation shows that the maximum tractive force that can be transmitted by the driving wheels is a function of both the effective dynamic axle weight W_d and the coefficient of road adhesion μ, as determined by existing road conditions (Part 1).

The type of drive—front, rear, or four-wheel—exerts a decisive influence on the magnitude of the transferable tractive force. Dynamic weight shift, for example, generally decreases front-axle weight,

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Limits of Vehicle Performance

- tractive force
- speed
- gradability
- acceleration
- drawbar pull

By JAROSLAV J. TABOREK*
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making the front-wheel drive system generally less effective than the rear-wheel system. The four-wheel drive, on the other hand, theoretically utilizes full vehicle weight.

In following calculations, it is assumed that the vehicle operates on a road without side elevation (no bank) and that the coefficients of road adhesion μ and rolling resistance f are identical for all vehicle wheels. With these assumed conditions, limits of performance can be calculated for all three drive types.

Tractive-Force Limits: The basic tractive-force relationship (Equation 137) can be employed to give vehicle tractive-force limits as outlined in the following section.

FRONT-WHEEL DRIVE: Designating maximum force and dynamic axle weight on the front wheels by $P_{f\,max}$ and W_{df}, respectively,

$$P_{f\,max} = W_{df}\,\mu \tag{138}$$

Substituting this expression into Equation 128.1 (Part 8),

$$W_{df} = \frac{L_r\,W}{L} - \frac{H}{L}\,(W_{df}\,\mu - f\,H) \tag{139}$$

After rearrangement, dynamic axle weight becomes

$$W_{df} = \frac{W(L_r + fH)}{L + \mu\,H} \tag{140}$$

Maximum transferable tractive force is then

$$P_{f\,max} = \mu\,W\left[\frac{L_r + fH}{L + \mu\,H}\right] \tag{141}$$

To simplify its handling in subsequent calculations, the bracketed term in Equation 141 can be designated by the symbol w, which is interpreted as the weight-distribution factor W_d/W. This is the ratio of effective weight on the driving axle to total vehicle weight. For the front-wheel drive vehicle, Equation 140 shows that the weight-distribution factor has the form

$$w_f = \frac{W_{df}}{W} = \frac{L_r + fH}{L + \mu H} \tag{142}$$

Equations 140 and 141 can then be written

$$W_{df} = W w_f \tag{143}$$

and

$$P_{f\,max} = \mu\,W w_f \tag{144}$$

REAR-WHEEL DRIVE: The basic equation for tractive force on the rear-wheel drive vehicle is

$$P_{r\,max} = \mu\,W_{dr} \tag{145}$$

Substituting this expression into Equation 128.2 and rearranging terms,

$$W_{dr} = \frac{W(L_f - fH)}{L - \mu H} \tag{146}$$

In this case, the weight-distribution factor w_r is identified as

$$w_r = \frac{L_f - fH}{L - \mu H} \tag{147}$$

The maximum transferable traction force is then

Example 3—Performance Limit Calculation

A vehicle has a gross weight of 3000 lb with the following weight distribution: $L_f = (0.55)(L)$, $L_r = (0.45)(L)$. Height of the center of the center of gravity H is $(0.35)(L)$; coefficient of rolling resistance f is 0.02. Performance limits, that is, maximum traction, maximum speed as limited by available friction, maximum gradability and maximum acceleration, are calculated in this example.

Maximum Traction Force: With an assumed value of 0.8 for the road-adhesion coefficient μ, maximum transferable traction forces for the three vehicle drive types are calculated in following sections.

FRONT-WHEEL DRIVE: Equation 142 gives the weight-distribution factor w_f as

$$w_f = \frac{(0.45)(L) + (0.02)(0.35)(L)}{L + (0.8)(0.35)(L)} = 0.357$$

From Equation 141, the maximum transferable tractive force is then

$$P_{f\,max} = (0.08)(3000)(0.357) = 860 \text{ lb}$$

REAR-WHEEL DRIVE: Equation 147 gives the weight-distribution factor as

$$w_r = \frac{(0.55)(L) - (0.02)(0.35)(L)}{L - (0.8)(0.35)(L)} = 0.755$$

From Equation 148, the maximum tractive force is

$$P_{r\,max} = (0.8)(3000)(0.755) = 1830 \text{ lb}$$

FOUR-WHEEL DRIVE: Equation 149, which assumes that full vehicle weight is utilized in producing traction, gives the result

$$P_{4\,max} = (0.8)(3000) = 2400 \text{ lb}$$

This equation is used with the understanding that tractive forces (and engine torque) are distributed to front and rear wheels according to the requirements of Equation 153, or

$$\frac{P_{4f}}{P_{4r}} = \frac{(0.45)(L) - (0.35)(L)(0.8 - 0.02)}{(0.55)(L) + (0.35)(L)(0.8 - 0.02)} = \frac{17}{83}$$

Meaning of this result is that the front axle produces 17 per cent and the rear axle 83 per cent of the total tractive effort. For comparison, the distribution is recalculated for a slippery road where $\mu = 0.2$:

$$\frac{P_{4f}}{P_{4r}} = \frac{(0.45) - (0.35)(0.2 - 0.02)}{(0.55) + (0.35)(0.2 - 0.02)} = \frac{38}{62}$$

These results show that the front axle utilizes 38 per cent and the rear axle 62 per cent of effective engine torque when the road surface becomes slippery. It is apparent that changes in optimum torque distribution for a four-wheel vehicle are appreciable when road surface conditions change from dry to wet.

Speed Limits: With an assumed coefficient of air resistance $c_a = 0.5$ and projected frontal area $A = 25$ sq ft, maximum vehicle speed as limited by available friction is calculated by use of Equation 158 in the following sections.

FRONT-WHEEL DRIVE:

$$V_{max} = 20\sqrt{\frac{3000[(0.357)(0.8) - 0.02]}{(0.5)(25)}}$$

$$= 159 \text{ mph}$$

REAR-WHEEL DRIVE:

$$V_{max} = 20\sqrt{\frac{3000[(0.755)(0.8) - 0.02]}{(0.5)(25)}}$$

$$= 240 \text{ mph}$$

FOUR-WHEEL DRIVE:

$$V_{max} = 20\sqrt{\frac{3000[(0.8) - (0.02)]}{(0.5)(25)}} = 278 \text{ mph}$$

Gradability Limits: Maximum gradability for dry concrete ($\mu = 0.8$) and for a slippery surface ($\mu = 0.2$) is calculated from Equation 162.

FRONT-WHEEL DRIVE: Value of the weight-distribution factor, found in a preceding part of the example, is $w = 0.357$.

For the dry surface ($\mu = 0.8$),

$$G_{max} = 100[(0.0357)(0.8) - 0.02] = 27 \text{ per cent}$$

For slippery surface ($\mu = 0.2$),

$$G_{max} = 100[(0.357)(0.2) - 0.02] = 5 \text{ per cent}$$

REAR-WHEEL DRIVE:

(*Dry surface*)

$$G_{max} = 100[(0.755)(0.8) - 0.02] = 58 \text{ per cent}$$

(*Slippery surface*)

$$G_{max} = 100[(0.755)(0.2) - 0.02] = 13 \text{ per cent}$$

FOUR-WHEEL DRIVE:

(*Dry surface*)

$$G_{max} = 100[(0.8) - (0.02)] = 78 \text{ per cent}$$

(*Slippery surface*)

$$G_{max} = 100[(0.2) - (0.02)] = 18 \text{ per cent}$$

It is interesting to note that under slippery surface conditions the front-wheel drive vehicle is not able to negotiate grades above 5 per cent, a value well within the range of grades encountered on normal highways.

Acceleration Limits: For vehicle operation on a level road in direct drive, acceleration limits are calculated from Equation 165. Assume γ is 1.1.

FRONT-WHEEL DRIVE:

$$a_{max} = \frac{g}{1.1}[(0.357)(0.8) - (0.02)]$$

$$= 0.26g = 8.3 \text{ ft per sec}^2$$

REAR-WHEEL DRIVE:

$$a_{max} = \frac{g}{1.1}[(0.755)(0.8) - (0.02)]$$

$$= 0.55g = 17.4 \text{ ft per sec}^2$$

FOUR-WHEEL DRIVE:

$$a_{max} = \frac{g}{1.1}[(0.8) - (0.02)]$$

$$= 0.73g = 23.3 \text{ ft per sec}^2$$

$$P_{r\,max} = \frac{\mu W (L_f - fH)}{L - \mu H} = \mu\, W w_r \qquad (148)$$

FOUR-WHEEL DRIVE: Substituting the expression

$$P_{4\,max} = \mu W \qquad (149)$$

alternately into Equations 128.1 and 128.2, dynamic axle weights on front and rear axles are

$$W_{4f} = \frac{W}{L}\,[L_r - H\,(\mu - f)] \qquad (150)$$

$$W_{4r} = \frac{W}{L}\,[L_f + H\,(\mu - f)] \qquad (151)$$

For the four-wheel drive arrangement, full vehicle weight is theoretically utilized in producing tractive forces. The weight distribution factor is

$$w_4 = 1 \qquad (152)$$

Such an ideal condition is realized, however, only when tractive forces (and engine torque) are distributed to the axles in the same proportion as are the dynamic weights on the respective axles. This condition can be expressed by the equation

$$\frac{P_{4f}}{P_{4r}} = \frac{W_{4f}}{W_{4r}} = \frac{L_r - H\,(\mu - f)}{L_f + H\,(\mu - f)} \qquad (153)$$

It is evident that on a four-wheel drive vehicle, optimum distribution of tractive forces is a function of the road adhesion coefficient μ. This means, however, that for theoretically maximum vehicle performance, the distribution of tractive forces must be adjusted to suit varying road conditions. Design attempts in this direction have been made but, because of the complexity of the mechanism required, no really satisfactory solution has been obtained. For the purposes of this article, tractive force distribution for the four-wheel drive vehicle is computed in Example 3 for a medium value of μ equal to 0.4.

Speed Limits: On level ground and at constant vehicle speed, tractive force is resisted by rolling and air resistances only. For this condition of motion,

$$P_{max} = W_d\,\mu = R_r + R_a \qquad (154)$$

Substituting for the air-resistance term the following expression (Part 6),

$$R_a = 0.26\, c_a A \left(\frac{V}{10}\right)^2 \qquad (155)$$

and for the rolling-resistance term

$$R_r = Wf \qquad (156)$$

Equation 154 can be written

$$W_d\,\mu = Wf + 0.0026\, c_a\, A\, V_{max}^2 \qquad (157)$$

When this equation is divided by W, the weight distribution factor $w = W_d/W$ can be substituted. The maximum speed in mph, as limited by available friction, is then

$$V_{max} = 20\sqrt{\frac{W\,(w\mu - f)}{c_a\, A}} \qquad (158)$$

where the corresponding values of w for front, rear, or four-wheel drive vehicles can be taken from Equation 142, 147, and 152.

The coefficient of rolling resistance f, which in an accurate calculation should be increased with speed, is considered constant in Example 3. The resulting error is negligible.

Gradability Limits: Because gradability limits are reached at low speeds, air resistance is con-

Nomenclature

A = Projected vehicle area in drive direction, sq ft
a = Acceleration, ft per sec^2
c_a = Coefficient of air resistance
D = Drawbar pull, lb
E = Kinetic energy, ft-lb
f = Coefficient of rolling resistance
g = Acceleration of gravity, ft per sec^2
H = Height of cg from ground, in.
H_a = Height of action point of air-resistance force, in.
H_d = Height of hitch point, in.
I = Polar moment of inertia, ft-lb-sec^2
L = Wheelbase, in.
L_f, L_r = Distances of cg from front and rear axles, in.
M_d = Torque on drive axle, lb-ft
M_e = Engine torque, lb-ft
m = Mass, lb-sec^2-ft^{-1}
P = Tractive force, lb
P_f, P_r = Tractive forces of front and rear-wheel drives, lb
P_{4f}, P_{4r} = Tractive forces on front and rear-wheel axles of a vehicle with four-wheel drive, lb
R_a = Air resistance, lb
R_g = Grade resistance, lb
R_i = Inertia resistance, lb
R_{it} = Inertia resistance of translatory mass, lb
R_r = Rolling resistance, lb
r = Rolling radius of tire, ft
V = Speed, mph
v = Speed, ft per sec
W = Vehicle weight, lb
W_d = Dynamic weight, lb
W_{df}, W_{dr} = Dynamic weights on front and rear axles, lb
W_d = Dynamic weight transfer in driving, lb
w = Weight distribution factor
w_f, w_r, w_4 = Weight distribution factors for front, rear and four-wheel drives
α = Angular acceleration, rad per sec^2
ζ = Reduction ratio
η = Transmission efficiency, per cent
γ = Mass factor of rotating parts
μ = Road-adhesion coefficient
σ = Stability factor
ω = Angular speed, rad per sec
θ = Slope angle, deg

sidered negligible. At constant speed, therefore, tractive force balances only rolling and grade resistances, and

$$P_{max} = R_r + R_g \tag{159}$$

After substitution of Equation 137 and the rolling and grade-resistance Equations 53 and 61 (Part 5), the resulting expression is

$$P_{max} = W_d \mu = fW + W \tan \theta_{max} \tag{160}$$

where θ_{max} is the maximum gradability angle. Dividing this equation by W, and substituting again for W_d/W the weight distribution factor w,

$$\tan \theta_{max} = w\mu - f \tag{161}$$

In place of the slope angle θ, the more practical value of G (per cent) (Equation 60, Part 5) can be substituted giving maximum gradability as

$$G_{max} = 100\ (w\mu - f) \tag{162}$$

Again w is substituted for front, rear, and four-wheel drive arrangements.

Acceleration Limits: Since maximum acceleration is reached at relatively low speeds, air resistance is again negligible and the tractive force balances the inertia resistance R_i, the rolling resistance R_r and the grade resistance R_g. The equation of vehicle motion, Equation 136, is then

$$am\gamma = P - (R_r + R_g) \tag{163}$$

Substituting the established values for R_r and R_g (Equations 53 and 61) and using $P = P_{max} = \mu W_d$,

$$\frac{a_{max} W \gamma}{g} = \mu W_d - Wf - W \sin (\pm \theta) \tag{164}$$

Dividing by W and introducing the weight-distribution factor w,

$$a_{max} = \frac{g}{\gamma} [w\mu - f - \sin (\pm \theta)] \tag{165}$$

Corresponding values of w for front, rear, and four-wheel drive vehicles can be substituted. For the correct value of sine θ, the approximate expression G/100 can be substituted.

Drawbar Pull Limits: If tractive force is used to produce drawbar pull D, equilibrium of forces (acceleration and air resistance neglected) is expressed as

$$W_d \mu = P_{max} = D_{max} + R_r + R_g \tag{166}$$

In this case, however, the simplified equations for dynamic axle weights W_d (Equations 128.1 and 128.2) cannot be applied since the height of the hinge point H_d is different from the cg height H. The correct equations for dynamic axle weights (Equations 125.1 and 125.2) with corresponding adjustments, $R_a = 0$, $R_{it} = 0$, are used for W_d, giving

$$W_{df} = \frac{1}{L} [L_r W - HW \sin (\pm \theta) - H_d D] \tag{167}$$

$$W_{dr} = \frac{1}{L} [L_f W + HW \sin (\pm \theta) + H_d D] \tag{168}$$

When these results are substituted into Equation 166, the following expressions are obtained for front, rear, and four-wheel drive vehicles:

FRONT-WHEEL DRIVE:

$$\frac{\mu}{L} [L_r W - HW \sin (\pm \theta) - H_d D_{max}] = D_{max} + fW + W \sin (\pm \theta) \tag{169}$$

and, for the maximum drawbar pull,

$$D_{max} = \frac{W(\mu L_r - fL)}{L + \mu H_d} - \frac{(L + \mu H) \sin (\pm \theta)}{L + \mu H_d} \tag{170}$$

REAR-WHEEL DRIVE:

$$\frac{\mu}{L} [L_f W + HW \sin (\pm \theta) + H_d D_{max}] = D_{max} + fW + W \sin (\pm \theta) \tag{171}$$

and

$$D_{max} = \frac{W(\mu L_f - fL)}{L - \mu H_d} - \frac{(L - \mu H) \sin (\pm \theta)}{L - \mu H_d} \tag{172}$$

FOUR-WHEEL DRIVE:

$$W\mu = D_{max} + fW + W \sin (\pm \theta) \tag{173}$$

and

$$D_{max} = W[\mu - f - \sin (\pm \theta)] \tag{174}$$

These equations include the horizontal grade term θ. For level ground, the sine term becomes zero and equations are correspondingly simplified.

In the next part of this series, the study of performance limits is continued and a roundup of equations used in such calculations is presented.

Tips and Techniques

Cosine Laws

When solving oblique triangles on a slide rule or with logarithms, the following forms for the law of cosines will be found more convenient than the standard forms:

$$\text{Cos } A = \frac{(a + b + c)(b + c - a)}{2bc} - 1$$

$$\text{Cos } B = \frac{(a + b + c)(a + c - b)}{2ac} - 1$$

$$\text{Cos } C = \frac{(a + b + c)(a + b - c)}{2ab} - 1$$

—F. MURRAY, *Chicago.*

Designing Vibration Mockups

Simple mockups for testing vibration characteristics can reduce costs. This article presents four basic mockup designs which duplicate physical characteristics of components and equipment.

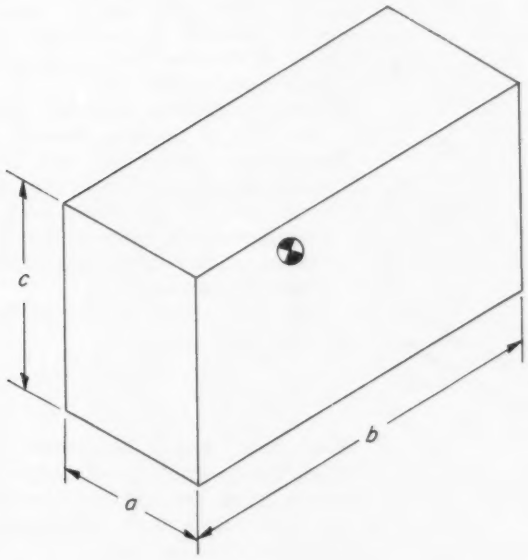
By **ALFRED HAFFNER**
Saint Louis, Mo.

MOCKUPS to replace components in vibration testing should approximate the physical dimensions, mass, and mass distribution of the original unit. Center of gravity location of the unit and density of the basic materials of the unit to be mocked up are two considerations which dictate type of construction. Constructions range from the simple solid-block type of Case 1, to the more complex hollow-box type with varied opposite wall thicknesses, Case 4.

Final weight checks must be made on all mockups. In solid-block constructions, final weight is achieved by drilling a hole along the axis of the center of gravity for lightening, or filling with lead for weight increases. In hollow-box constructions, if the final weight cannot be achieved by using standard stock thicknesses, the mockup should be made overweight and lightening holes drilled along the axes of the center of gravity.

Nomenclature

a, b, c	= Exterior dimensions
D	= Density of body mockup material
d	= Density of ballast plate material
e	= Length of mockup including ballast plate thickness
f	= Length of mockup body
g, j, x	= Distance from reference end of mockup to center of gravity axis
h	= Distance from center of gravity axis to inner wall surface
k	= Distance from center of gravity axis to inner surface of opposite wall
M	= Mass of the mockup
t	= Wall thickness



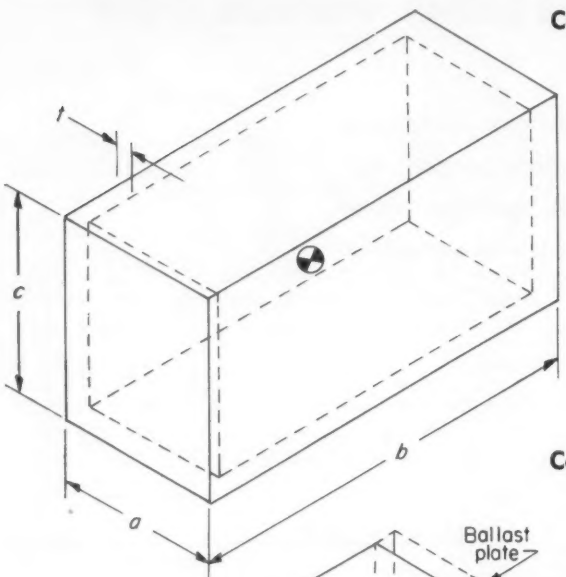
Case 1

Center of Gravity: At the geometric center of the unit.

Density of Mockup Material: Approximately equal to that of the unit material.

Construction: Solid block.

Case 2



Center of Gravity: At the geometric center of the unit.

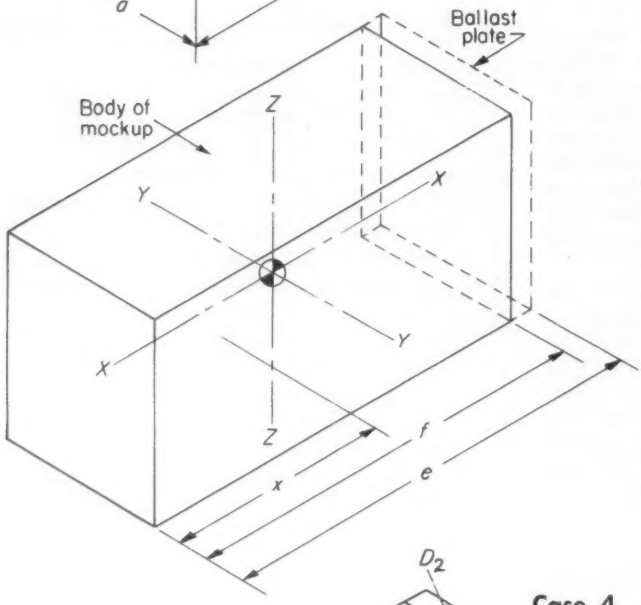
Density of Mockup Material: Greater than that of the unit material.

Construction: Hollow box with opposite walls of the same material and thickness.

Thickness, t, necessary to accomplish the desired weight may be calculated from:

$$t^3 - \frac{t^2}{2}(a + b + c) + \frac{t}{4}(ab + bc + ca) - \frac{M}{8D} = 0$$

Case 3



Center of Gravity: Not at the geometrical center of the unit.

Density of Mockup Body Material: Nearly equal to that of the unit material.

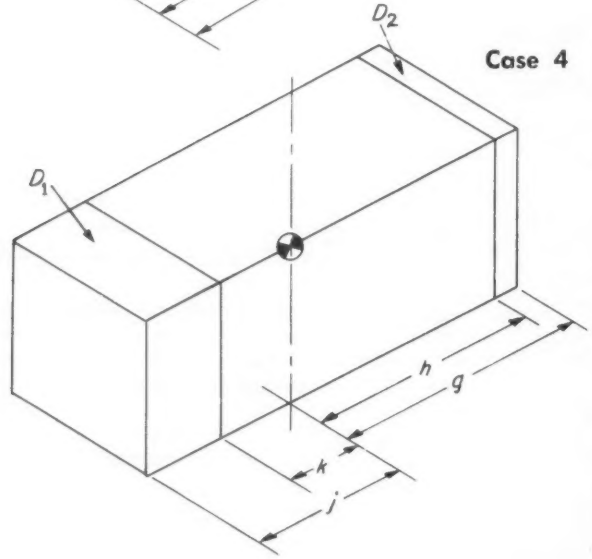
Construction: Solid-block body and ballast plate of different density material. Body material may be plywood (density, 0.022-lb/cu in.) or birch (density, 0.026-lb/cu in.). A ballast plate is attached to the box to shift the center of gravity along the appropriate axis; the plate may be aluminum (density, 0.098-lb/cu in.).

Thickness, $e - f$, of the ballast plate may be calculated from:

$$f = x \pm x\left[\ (d - D)^2 - \frac{de}{x^2}(D - d)(e - 2x)\ \right]^{1/2} \div (D - d)$$

The same relation also holds for shifts of center of gravity along the Y and Z axes.

Case 4



Center of Gravity: Not at the geometrical center of the unit.

Density of Mockup Material: Greater than that of the unit material.

Construction: Hollow box with opposite walls of different materials of the same or different thicknesses. An alternate consideration in this case is the use of the same material of different thicknesses.

Thickness, $g - h$, of an opposite wall may be found from:

$$h = \sqrt{g^2 - (j^2 - k^2)\frac{D_1}{D_2}}$$

Note that j and k are known dimensions. This method is only an approximation since the effects of end plates (at right angles to the segments under consideration) are neglected.

17 *practical solutions to design problems with*

Combination Spring Assemblies

By FRANK A. VOTTA JR.
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Springs in Series

Four common design requirements can be satisfied by combining springs in series arrangements. To compensate for end twist or end torque, the assembly at *a* employs two identical springs, one having left-hand wind and the other right-hand wind, mounted in series. Series arrangements can also be used, as at *b*, to steeply increase the gradient at points of critical deflection. This condition exists when one of the springs closes out first.

In the design at *c*, a high reduction ratio is achieved with simple levers and two springs in series. At *d*, a long length of spring material is fitted into a restricted body space by combining springs in series.

Series combinations of springs are calculated on the basis that the load on each spring, or coil, is the same and, therefore, the deflections are additive. Thus,

$$F_1 = \frac{P}{K_1}$$

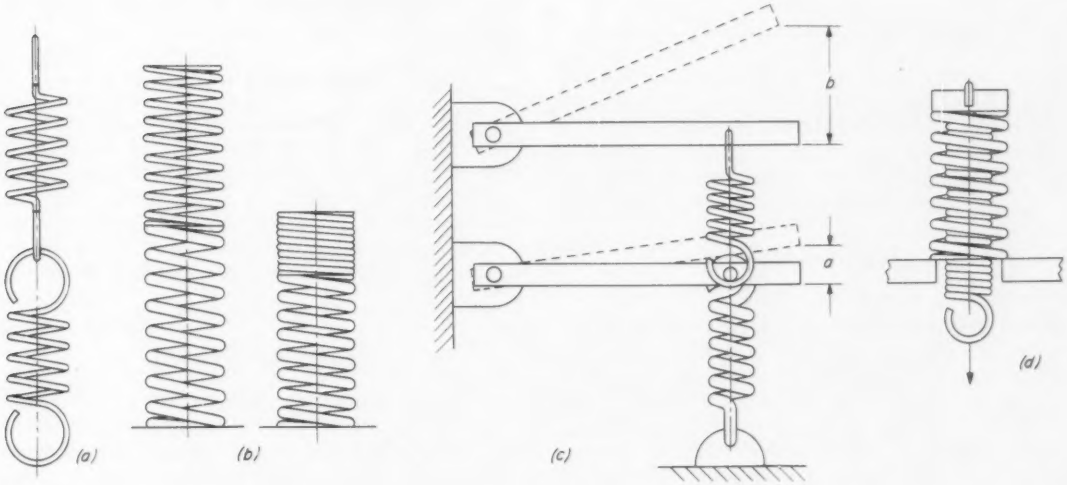
$$F_2 = \frac{P}{K_2}$$

where F = spring deflection, in.; P = load, lb; K = spring gradient, lb per in.; and subscripts identify individual spring elements. Total deflection becomes

$$F = F_1 + F_2 = \frac{P}{K_1} + \frac{P}{K_2} = \frac{P}{K}$$

and the combined gradient, K, of a series spring system is

$$\frac{1}{K} = \frac{1}{K_1} + \frac{1}{K_2} + \frac{1}{K_3} + \ldots + \frac{1}{K_n}$$



Springs in Parallel

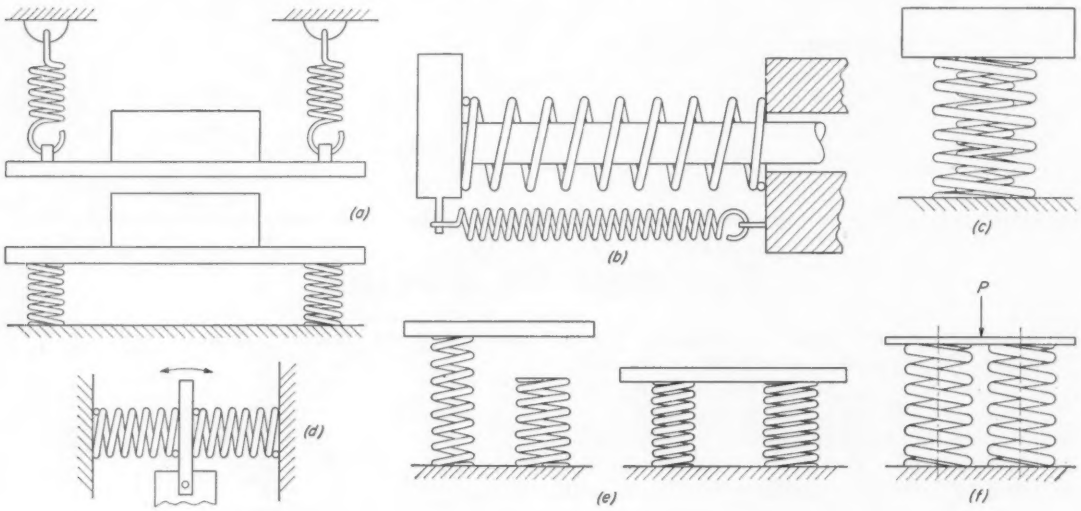
In design, springs in parallel can be used to: *a*, provide shock mountings; *b*, obtain adjustment of a heavier spring by a lighter spring; *c*, conserve space; *d*, center or balance an object between forces; or *e*, cause sudden changes in gradient to occur at a specific deflection.

Parallel combinations of springs are designed and calculated on the basis that working deflections are identical and that the loads are additive, as depicted at *f*. Thus, in equation form,

$$F = F_1 = F_2 = \frac{P_1}{K_1} = \frac{P_2}{K_2}$$

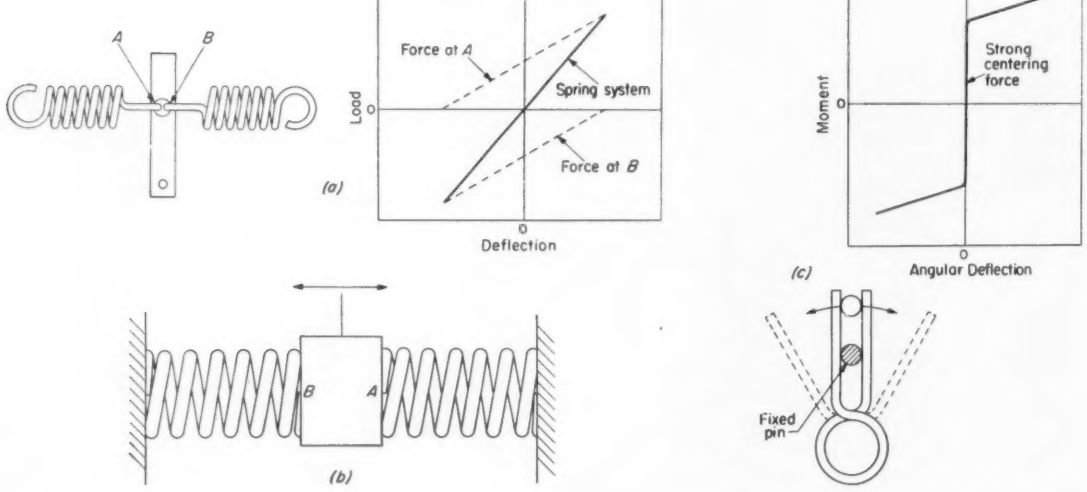
Combined gradient of a parallel spring system is therefore the sum of the individual gradients,

$$P = P_1 + P_2 = FK_1 + FK_2 = FK$$



Centering Springs

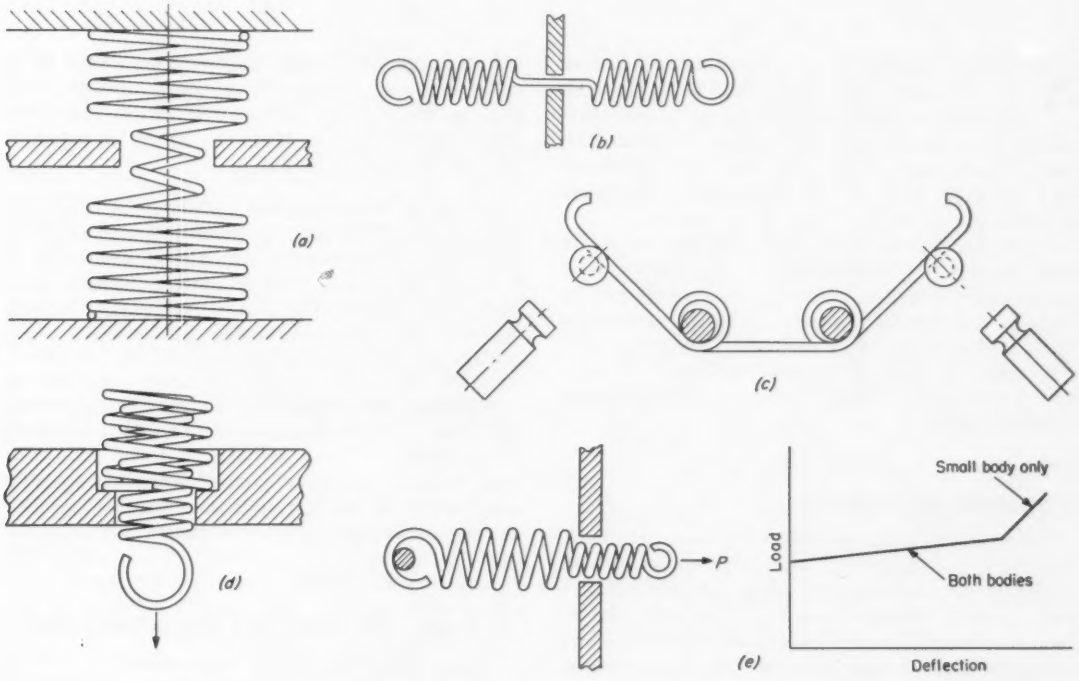
For centering objects, opposed springs offer a simple and effective approach. Typical mounting arrangements for this purpose and corresponding spring operating characteristics are shown here for: *a*, pairs of identical extension springs; *b*, compression springs; and *c*, a single torsion spring that serves two functions. Load-deflection characteristics of the two centering spring designs shown at *a* and *b* are basically the same.



Double Springs

To save end fittings, conserve wire, eliminate manufacturing operations or reduce installation difficulties, two springs often can be combined in a single member. Design at *a* has compression springs operating on both sides of the same plate or member. At *b*, an extension spring operates through a web or septum. Double torsion springs, *c*, can save space and installation time.

In the construction at *d*, the compression spring is loaded through an extension spring in a single component. Extension spring design shown at *e*, along with typical load-deflection curve, provides a sudden change in gradient when the large body seats on the rim of the hole in the plate member.



Tips and Techniques

Flattening Rolled Paper

Blueprints, tracings and similar forms of paper, if stored in a roll for any period of time, develop a permanent tendency to re-roll if spread out. This set may be removed by slowly running them through the developing section of a printing machine. Due to the moisture absorbed, the papers will lie flat afterwards.—EVELYN DUTCHER, *Oshkosh, Wis.*

Lettering on Prints

When doing ink lettering on prints, time can be saved by inserting a ballpoint refill unit into a standard lead-holder. Lettering guides may be used. A refill may be inserted into the scriber socket for use with LeRoy units instead of the regular inking device. The method is useful for short jobs and cleaning afterward is eliminated. For inking directly on a drawing, a black-ink refill may be used.—JIM BLAIN, *Lockheed Aircraft Corp., Missiles Systems Div., Van Nuys, Calif.*

Pencil Point Cleaner

A cleaner for removing graphite dust from newly sharpened pencils may be constructed from a granulated art gum bag. Remove the top portion of the cardboard box containing the bag, leaving the bag inside. To clean the pencil point, thrust the tip into bag with a twisting motion.—EDWIN L. GORDON, *Fairchild Engine and Airplane Corp., Stratos Div., Manhattan Beach, Calif.*

DESIGNING WITH TEFLON

SEVERAL engineering properties of Teflon tetrafluoroethylene plastics will be reviewed in this article. They are (1) strength and stiffness, and (2) creep, cold flow and stress relaxation. Based upon engineering information supplied by E. I. du Pont de Nemours & Co. Inc., this article presents property data and design methods.

A graphical approach is used, relating values for each property to crystallinity of the Teflon. How crystallinity can be controlled by processing to produce the desired property value is covered in Part 1 of this series in the Sept. 5 issue of MACHINE DESIGN, Page 86. Some indication of practical crystallinity ranges, however, is given on each property curve.

Strength and Stiffness

Strength and stiffness properties of an engineering material are among the first considerations explored by the designer when contemplating a new product design. Tetrafluoroethylene plastic, with its unusual properties, can be utilized to solve many difficult design problems in the electrical, mechanical, and chemical industries.

The same engineering formulas are used with the same general design approach to obtain theoretically sound designs. These designs, when modified to incorporate actual fabricating and field test experience, will result in sound, economical fabricated parts of Teflon.

Strength Characteristics: Curves in Figs. 10 through 13 can be used by the designer to calculate structural requirements for fabricated parts of Teflon plastics in a manner similar to other engineering materials. The safety factor used in conjunction with this information is a judgment factor established by the designer.

Stiffness Considerations: Relationship between modulus of elasticity and crystallinity is shown in Fig. 13.

Fabricated parts of tetrafluoroethylene resin have relatively good strength and stiffness properties over a wide temperature range.

Creep, Cold Flow, and Stress Relaxation

These important subjects are presented here to provide the designer with the data necessary to predict creep, cold flow, and stress relaxation in

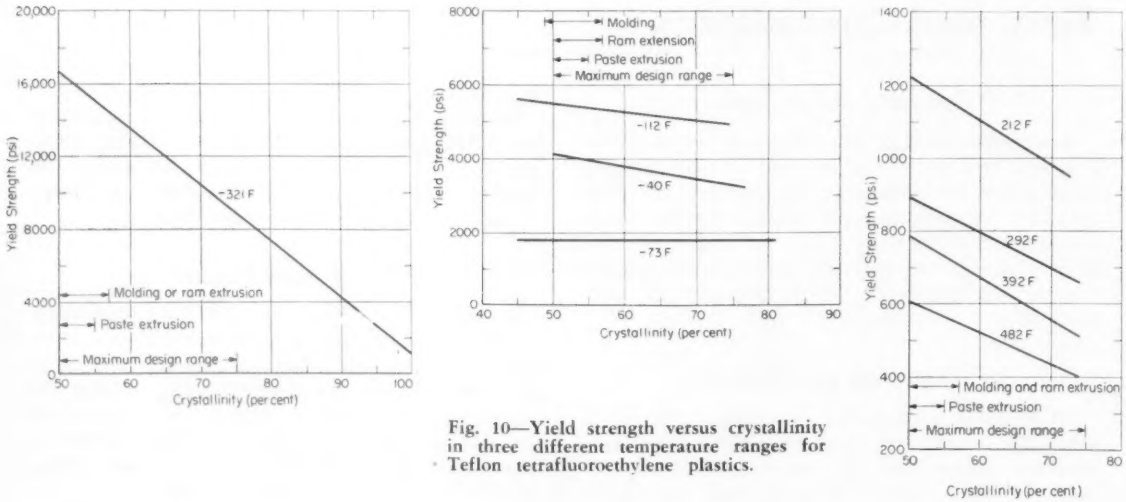


Fig. 10—Yield strength versus crystallinity in three different temperature ranges for Teflon tetrafluoroethylene plastics.

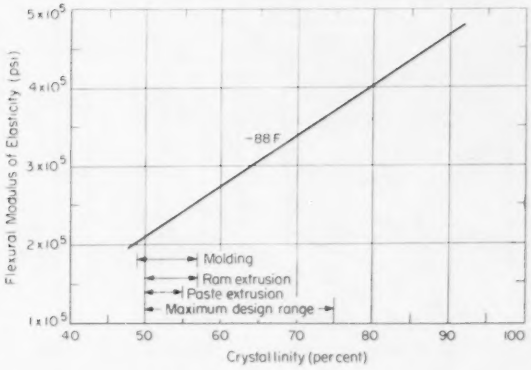
Part 2—Strength Properties and Effects of Time

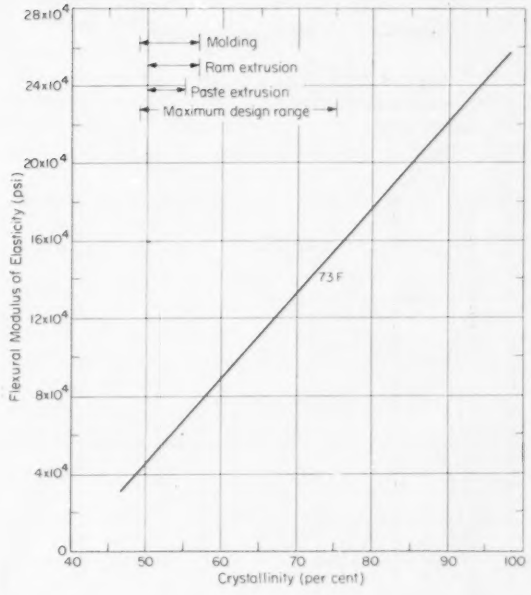
designing products fabricated of Teflon.

Creep (Cold Flow, Deformation with Time): When a part is stressed under load for a short period of time (below the proportional limit), deformation will occur in proportion to the unit stress imposed on the part.

Deformation, as a percentage of original thickness, for various compressive loads at various temperatures is shown in Fig. 14. Note that as these samples are compressed at different temperatures up to a stress level of 8000 psi, deformation increases accordingly. When the compressive load is decreased, total deformation remains essentially constant until a load of slightly less than 2000 psi is encountered. Below this level, deformation decreases and some recovery takes place. Even at no load, about half the total deformation still remains.

Deformation with time, sometimes referred to as creep or cold flow, is a consideration which





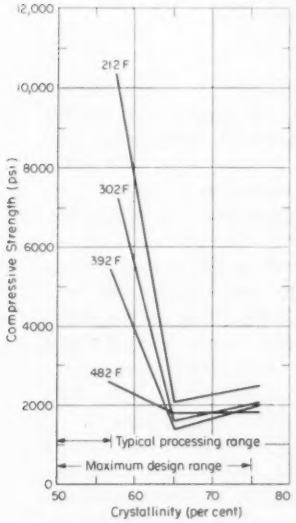


Fig. 11—Compressibility of Teflon plastics.

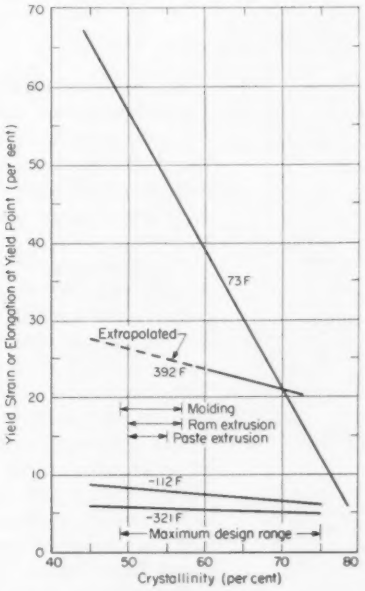


Fig. 12—Yield strain (elongation at yield point) for Teflon.

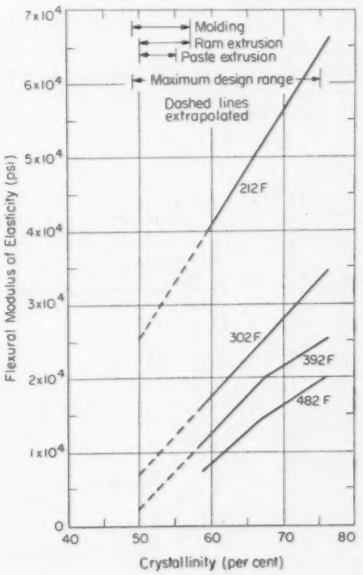


Fig. 13—Flexural modulus of elasticity in three temperature ranges.

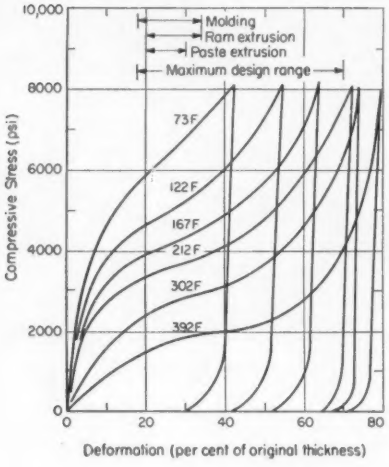
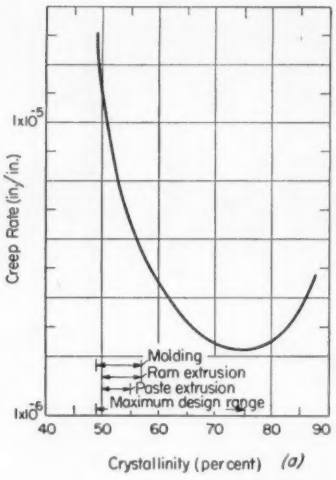


Fig. 14—Compressive stress curves for Teflon 1.



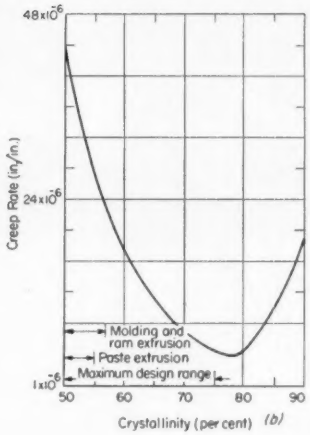


Fig. 17—Creep rate as a function of crystallinity for 100 hr at: *a*, 500 psi; *b*, 1000 psi.

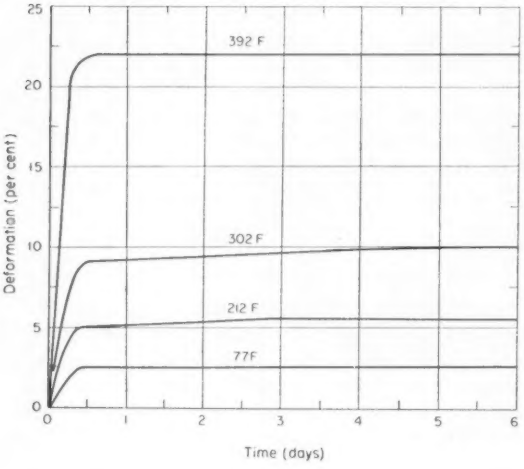


Fig. 15—Deformation versus time for Teflon 1 in compression at 1000 psi.

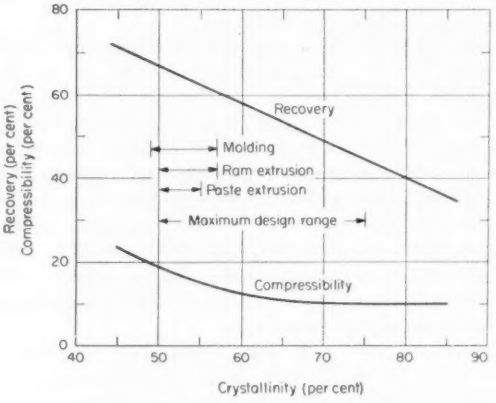


Fig. 18—Recovery and compressibility versus crystallinity.

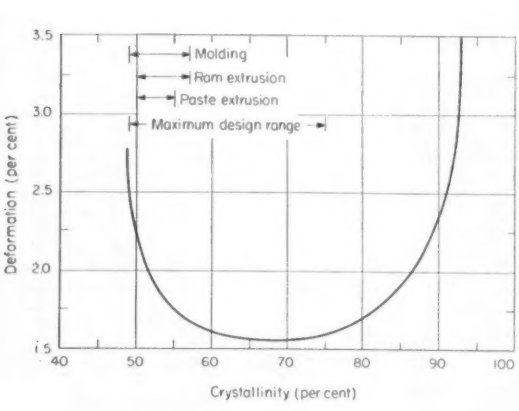


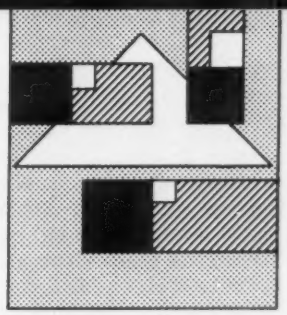
Fig. 16—Deformation versus crystallinity for Teflon held at 1000 psi for 24 hr at 74 F.

must be occasionally explored by the designer. Parts which are subjected to continuous loading for long periods of time must be designed so that the part does not fail due to creep. The part under consideration might be a gasket in a flanged joint or a seal ring in a mechanical seal for a chemical pump.

Fig. 15 shows the deformation which occurs when a part fabricated from Teflon is subjected to a compressive loading of 1000 psi. Most of the deformation occurs within several hours and, in most cases, reaches a constant value in several days. Relationship of deformation and creep rate with crystallinity is shown in Figs. 16 through 18.

The apparent modulus is a convenient method of expressing creep. Figs. 19 through 23 show curves giving the variation in apparent modulus with time at various temperatures, crystallinities, and stress levels for various compositions fabricated from Teflon.

The concept of "apparent modulus" can most easily be explained as follows. As long as the



stress level is below the proportional (elastic) limit of the material, the modulus of elasticity E is

$$E = \frac{\text{Stress (psi)}}{\text{Strain (in./in.)}}$$

Suppose stress is 2000 psi and strain is 0.01-in./in. Then

$$E = \frac{2000}{0.01} = 200{,}000 \text{ psi}$$

If the same stress level prevails for 10 hr, the total strain will be the sum of the initial strain plus the strain (deformation) due to time (or creep). If this total strain is substituted in the previous equation, the apparent modulus can be calculated as:

$$E_A = \frac{\text{Stress (psi)}}{\text{Initial strain + Creep}}$$

If creep for 10 hr is assumed to be 0.004-in./in., then

$$E_A = \frac{2000}{0.01 + 0.004} = 140{,}000 \text{ psi}$$

Similarly E_A can be determined for one year (assume 0.011-in./in. creep) as

$$E_A = \frac{2000}{0.01 + 0.011} = 95{,}000 \text{ psi}$$

These experimentally determined values for the "apparent" modulus when plotted against time, provide an excellent means for predicting creep at various stress levels below the yield strength of the material.

It is important to note that the curve for the "apparent" modulus for all practical considerations levels out in time. Beyond this time, creep is small and for most applications can be neglected.

Stress Relaxation: Stress relaxation is a phe-

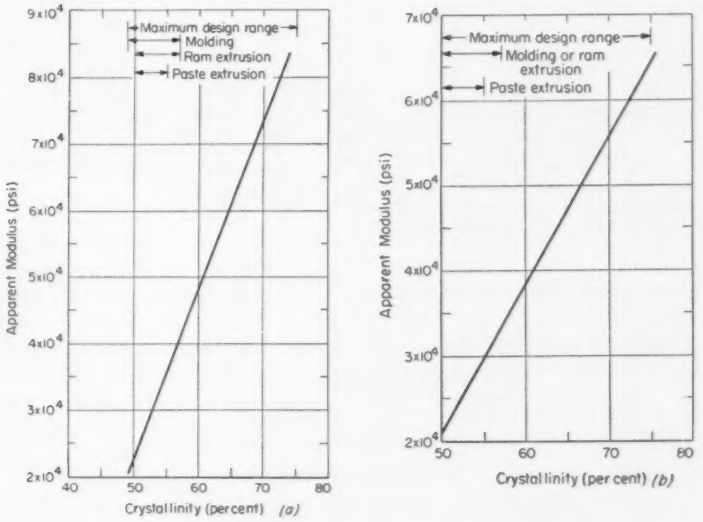
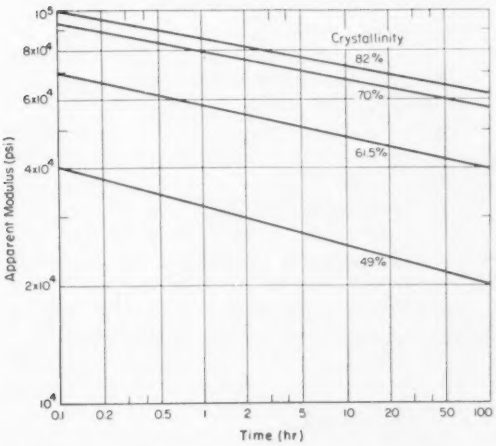


Fig. 19—Right—Apparent modulus as a function of crystallinity at 100 hr and: *a*, 500 psi; *b*, 1000 psi.

Fig. 20 — Below — Apparent modulus related to crystallinity and time.



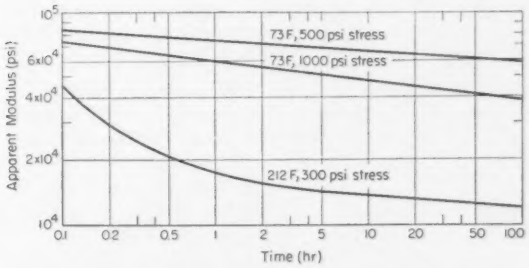


Fig. 21—Apparent modulus related to stress and time for Teflon 1.

nomenon generally encountered when materials, subject to creep or cold flow, are used as gaskets in flanged joints. Under a compressive stress, usually encountered in flanged bolted connections, parts fabricated from tetrafluoroethylene resins, as well as other materials such as lead, will cold flow between the flange faces and result in a decrease in bolt pressure.

This decrease in bolt pressure is due to stress relaxation in the gasket stock and can be troublesome, as a leaky joint may result. Tightening the flange bolts during the first days after installation will maintain bolting pressure and prevent leakage; thereafter, stress relaxation will be negligible.

Fig. 24 shows the stress relaxation of sheet stock fabricated from Teflon tetrafluoroethylene resins and the same stock reinforced with Fiberfrax (Carborundum Co.). Note that the stress relaxation is not a factor after 10 hr when using the reinforced material, since the curve has reached a constant value.

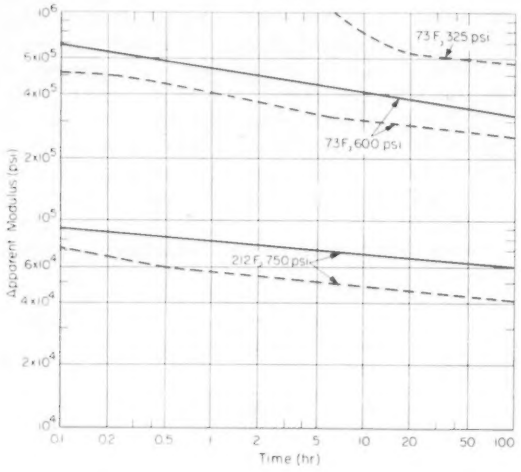


Fig. 22—Apparent modulus versus time for sheet molded of Teflon resin reinforced with glass fiber. Solid lines are 75:25 weight ratio; dashed lines are 85:15.

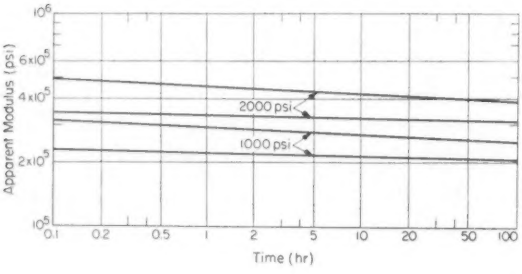


Fig. 23—Apparent modulus versus time for laminate made of sheets of molded Teflon resin reinforced with glass cloth; laminate is 5 by 5 by ½-in. thick. Top lines for each stress level are at 73 F, bottom lines at 212 F.

Design Recommendations: To alleviate stress relaxation in gaskets, the following recommendations should be followed.

1. Bolting loads less than 1000 psi should be used for unconfined gaskets.
2. The gasket should be as thin as possible (approximately 1/16-in.), since thicker gaskets increase the amount and rate of stress relaxation.
3. Reinforced tetrafluoroethylene resins, such as 60 per cent Teflon and 40 per cent Fiberfrax, should be used at temperatures of 300 F and higher.
4. In some cases, it is desirable to design the joint to "self-contain" the gasket of Teflon tetrafluoroethylene resin.

Calculation of Bolt Loading: Calculation of the required bolt loadings for solid gaskets of Teflon tetrafluoroethylene resins is based on the procedure suggested in the 1952 ASME Boiler and Pressure Vessel Code, Section VIII, Appendix II. The formulas are:

$$W_{m1} = H = H_p + 0.785\,G^2\,P + 2b \times 3.14\,GmP$$

$$W_{m2} = H_y = 3.14\,bGy$$

where W_{m1} = required operating bolt load, psi; H = hydrostatic end force, psi; H_p = compression load on gasket, psi; W_{m2} = required initial bolt load for normal conditions (no internal pressure), psi; H_y = load on gasket to assure a tight joint,

Table 16—Gasket Factors for Teflon

Thickness (in.)	Gasket Yield Stress y (psi)	Gasket Factor m
1/8	1600	2.00
3/32	2000	2.50
1/16	3700	2.75
1/32	6500	3.50

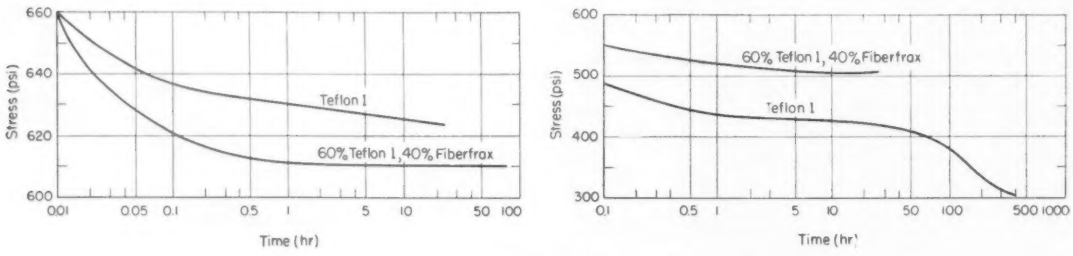


Fig. 24—Stress relaxation versus time for an unconfined gasket, 1/16-in. thick at: left, 212 F; right, 300 F.

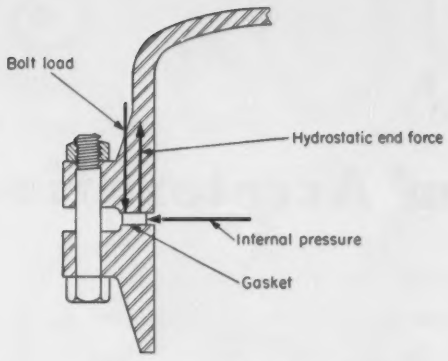


Fig. 25—Forces acting on a gasket.

psi; b = effective gasket joint contact (surface seating width), in.; G = diameter at location of gasket load reaction, in.; P = internal working pressure, psi; y = yield stress, or the minimum stress required to effect a seal against even slight fluid pressure, psi; and m = gasket factor or the minimum required ratio of resultant stress on the gasket and the internal pressure.

As internal pressure is applied to the vessel, it tends to separate the flanges, thus lowering the effective stress on the gasket, as shown in Fig. 25. Obviously, maintenance of a seal requires that the resultant stress on the gasket exceed the internal pressure. The minimum required ratio of these pressures is called the gasket factor, m. Values of y and m outlined in Table 16 for solid Teflon have been proved through experience.

As with other gasket materials, thinner gaskets of tetrafluoroethylene are preferred if they will accommodate existing misalignment and roughness of the flanges. A thickness of 1/16-in. has been widely used and serves most gasket applications adequately.

Excellent gaskets are fabricated from molded Teflon, and they are used extensively in corrosive service. Gaskets in a variety of shapes and types are used to meet desired design requirements.

Envelope gaskets (asbestos or rubber in an envelope of molded tetrafluoroethylene) are widely used for flanged connections to glass-lined reaction vessels and in glass-lined pipe. Spiral-wound gaskets of stainless steel and sheet stock of Teflon have been successfully used in both large and small flanged joints where high bolting pressures are required. Molded tetrafluoroethylene plastics, either singularly or in combination with other gasket materials, give excellent service in the most corrosive conditions encountered in the chemical industry.

Next article in this series will cover the remaining engineering properties of tetrafluoroethylene resins—effect of temperature and chemicals, fatigue and impact characteristics, frictional and abrasion properties, and electrical properties.

They Say . . .

"A little thought shows that the detailed working drawings are actually the very first real embodiment of the idea itself. The idea or scheme can have no existence, apart from a mental conception, without the drawings, which represent the body in which the spirit of the idea can take shape, and appear to human eyes for the first time. We are now getting near to the heart of the matter. Who does the design? Who directs or supervises, or even more important, who actually executes the translation from a mental conception into a tangible and visible form?

"The place where quality is injected in the product is on the drawing board, and the instrument used for injecting it is a pencil. It is in this stage that the realities of quality, character, and performance of the hardware are determined. The idea by itself, even if supported by acres of specifications, mathematics, diagrams, sketches and figures, only gives, at best, the potentialities of the conception, and not even all of those. The first step towards reality lies in the design, i. e., the working drawings. This stage will, in general, need as much care and attention as the formulation of the idea, or the research and experimental work, at an intellectual level which, though different in kind, will be precisely similar in degree, if success is to be achieved."—HUGH CLAUSEN.

"We have shortages of trained manpower in almost every department of business and government. These shortages are of two kinds. In the first place, we have so enlarged our demands for technically trained personnel that we have outrun our population with respect to the age groups from which we must draw productive personnel. In the next place, among the growing numbers of high school and college students only a certain fraction have the mental endowment to enable them to pursue with profit to themselves or the nation the intellectual and technical studies requisite to meet today's opportunities.

"It is for us in education and industry to mobilize our resources so that no alert and eager youngster may be dissuaded from pursuing further studies in science and engineering. The best incentive to recruitment of students for classes in science is sound and rewarding instruction."—ROY E. SIMPSON, *superintendent of public instruction, State of California.*

A Graphical Method of

Modifying Cam Accelerations

OFTEN the cam designer is faced with the problem of selecting cam-cutter displacements from a previously established table of displacements at the output end of the system. In following this output pattern, he will not be free to design the cam by considering only a few limiting conditions of lift, velocity, and acceleration. Such defined conditions would enable him to choose one or more of the standard cam shapes, such as the harmonic, parabolic, or cycloidal form. Also, the use of other cam formulas relating output movement to cam-cutter displacement may not be practical without resorting to computers for their lengthy solution. This problem arises particularly with swinging-arm type of roller followers.

Instead, the quickest and most direct answer may be a point-by-point layout, perhaps ten times actual size, with the work proceeding from the desired motion back through the system to develop the cam contour. One of the drawbacks to this method is the erratic shape of the acceleration curve caused by taking the second difference of these plotted and scaled displacement values. Often, displacements to the nearest ten-thousandth of an inch are of concern. Scaling plotted points to this degree of accuracy even on an enlarged layout cannot be done precisely enough to produce a smooth acceleration curve. A portion of a typical acceleration curve derived in such a manner is shown in Fig. 1.

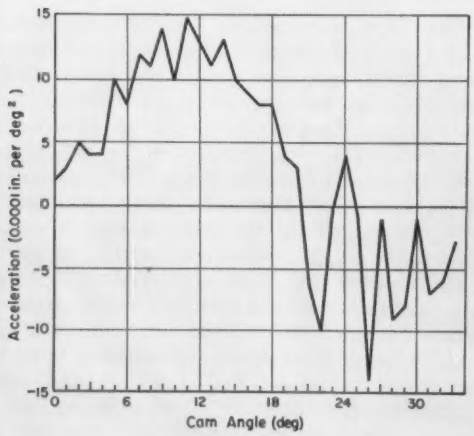


Fig. 1—Portion of an acceleration curve derived from scaled lifts.

High acceleration values produce high stresses and consequent wear or fatigue failure. High deceleration values bring about cam follower jump at relatively low speeds. Also, the smoothness of the acceleration curve, or rate of change of acceleration, affects impact loads and vibration characteristics of the system. Consequently the acceleration curve should have no abrupt changes and the height of its peaks and valleys should be held to a minimum. The problem then is in smoothing out the "irregularities" in this curve without altering the general shape of either the velocity curve or the lift curve.

This article presents a graphical method for smoothing accelaration curves.

First, the acceleration values are obtained as previously mentioned—taking the difference of successive velocity values. Velocity values are obtained similarly from the scaled lift values. Plotting the acceleration values against their respective cam angles as vertical bars produces a chart similar to that shown in Fig. 2. This figure resembles a series of stacked "blocks." To smooth out the entire curve, these blocks may be shifted; the peaks may be lowered to fill in the valleys. However, several important rules govern the shifting of these blocks.

1. No blocks can be added or taken away, only shifted. An acceleration block removed from one position increases the velocity at that point, but by adding it to another stack, the velocity is decreased and the overall velocity curve remains essentially unchanged.

By ROBERT LENZ
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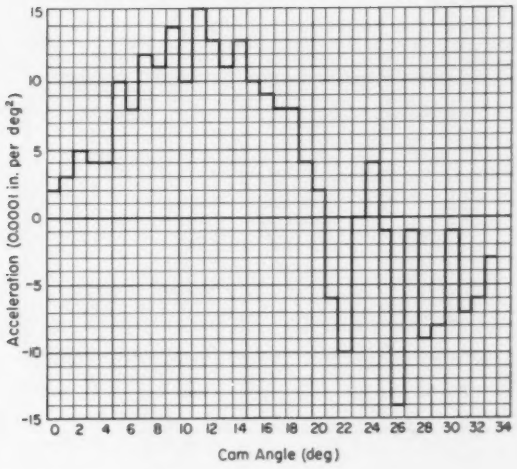

Fig. 2—Block diagram of acceleration curve.

2. The blocks must remain "statically balanced" across the entire diagram. That is, the product of blocks shifted in one direction and their spaces moved must equal the product of spaces moved times blocks shifted in the opposite direction. When one block is moved two spaces, it must be balanced either by moving two blocks one space or one block two spaces in the opposite direction.

3. The chart must be continuous from acceleration into deceleration. However, the deceleration values must be considered somewhat differently. Instead of positive blocks, the absolute values of the deceleration can be thought of as void blocks or empty spaces with the positive blocks covering the area beneath them. This allows blocks in the acceleration portion to be shifted into the deceleration voids, preserving the continuity of the system. Therefore, whether positive or negative accelerations are plotted, only the blocks directly under each value can be considered as positive.

Fig. 3 illustrates this modifying method as applied over the first few values of the curve of Fig. 2. Here the positive block identified as *A* is shifted one space to the right filling in the shaded area *A*. The two blocks lettered *B* are then moved one space each to the left. To balance the system, block *C* is moved one space to the right into the shaded area *C*. Thus, two blocks are moved one space each to the right and two other blocks are moved one space each to the left. It is not necessary, as happened in this instance, that the number of blocks moved in opposite directions be equal. Only the number of blocks times the spaces moved must be equal. For instance, one block may be moved four spaces and, in balancing this, four blocks may be moved one space, two blocks may be moved two spaces, or one block four spaces, as required by the roughness of the curve. Also, positive values (acceleration) may be shifted into spaces created by the negative values (deceleration) as noted before.

It is recommended that the smoothing operation be carried out by moving blocks the minimum amount necessary, and that this be done progres-

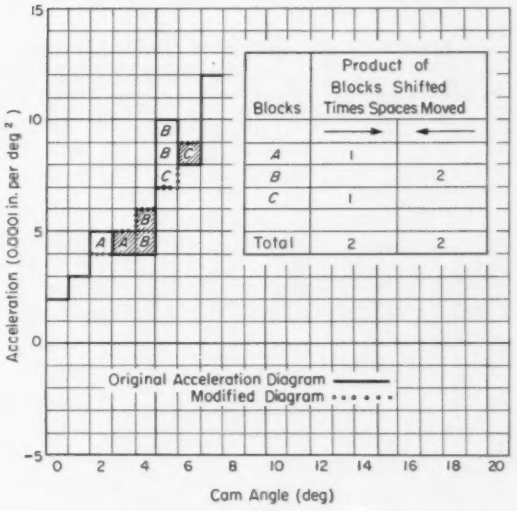

Fig. 3—Example of block shifting and tabulation.

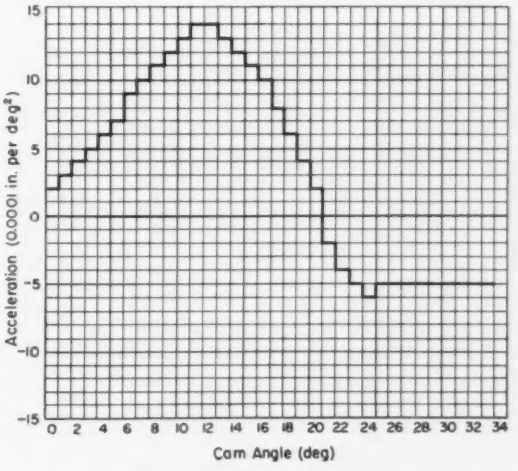

Fig. 4—Modified acceleration diagram.

MODIFYING CAM ACCELERATIONS

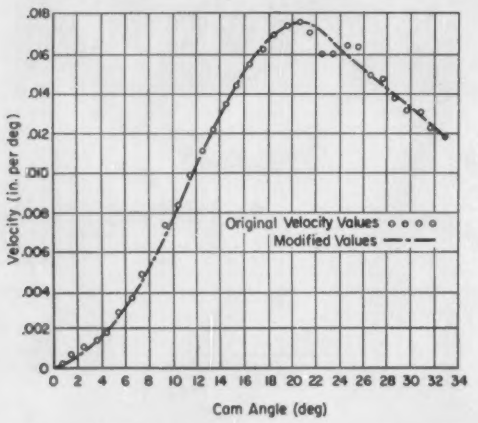

Fig. 5—Modified velocity curve, illustrating close similarity to original shape and individual values.

Table 1—Data for Typical Profile Adjustment

Cam Angle	Scaled Displ.	Orig. Vel. (Fig. 5)	Orig. Accel. (Fig. 1&2)	Modified Accel. (Fig. 4)	Adj. Velocity (Fig. 5)	Final Displ.
0	.0000		.0002	.0002		.0000
		.0002			.0002	
1	.0002		.0003	.0003		.0002
		.0005			.0005	
2	.0007		.0005	.0004		.0007
		.0010			.0009	
3	.0017		.0004	.0005		.0016
		.0014			.0014	
4	.0031		.0004	.0006		.0030
		.0018			.0020	
5	.0049		.0010	.0007		.0050
		.0028			.0027	
6	.0077		.0008	.0009		.0077
		.0036			.0036	
7	.0113		.0012	.0010		.0113
		.0048			.0046	
8	.0161		.0011	.0011		.0159
		.0059			.0057	
9	.0220		.0014	.0012		.0216
		.0073			.0069	
10	.0293		.0010	.0013		.0285
		.0083			.0082	
11	.0376		.0015	.0014		.0367
		.0098			.0096	
12	.0474		.0013	.0014		.0463
		.0111			.0110	
13	.0585		.0011	.0013		.0573
		.0122			.0123	
14	.0707		.0013	.0012		.0696
		.0135			.0135	
15	.0842		.0010	.0011		.0831
		.0145			.0146	
16	.0987		.0009	.0010		.0977
		.0154			.0156	
17	.1141		.0008	.0008		.1133
		.0162			.0164	
18	.1303		.0008	.0006		.1297
		.0170			.0170	
19	.1473		.0004	.0004		.1467
		.0174			.0174	
20	.1647		.0002	.0002		.1641
		.0176			.0176	
21	.1823		−.0006	−.0002		.1817
		.0170			.0174	
22	.1993		−.0010	−.0004		.1991
		.0160			.0170	
23	.2153		.0000	−.0005		.2161
		.0160			.0165	
24	.2313		+.0004	−.0006		.2326
		.0164			.0159	
25	.2477		−.0001	−.0005		.2485
		.0163			.0154	
26	.2640		−.0014	−.0005		.2639
		.0149			.0145	
27	.2789		−.0001	−.0005		.2788
		.0148			.0144	
28	.2937		−.0009	−.0005		.2932
		.0139			.0139	
29	.3076		−.0008	−.0005		.3071
		.0131			.0134	
30	.3207		−.0001	−.0005		.3205
		.0130			.0129	
31	.3337		−.0007	−.0005		.3334
		.0123			.0124	
32	.3460		−.0006	−.0005		.3458
		.0117			.0119	
33	.3577		−.0003	−.0005		.3577
		.0114			.0114	
34	.3691					.3691

sively from the beginning of the cam lift to the end by small steps. A running record of positive and negative products, as shown in the tabulation in Fig. 3, simplifies the procedure and provides a visual check on maintaining minimum changes. Fig. 4 shows the original acceleration curve smoothed out to a satisfactory shape.

Fig. 5 illustrates the effect of this modifying system on the original velocity curve. The maximum value, the individual values, and the general shape have been followed quite closely. Since no noticeable changes have occurred in the lift curve, an illustration of it has been omitted.

All of the numerical data for the example shown are given in Table 1.

Often a plot of the acceleration values results in a curve so erratic that the general shape is beyond recognition. When this is the case, a very close first approximation may be made by plotting the velocity values as originally derived and drawing a smooth curve among the points. By scaling the slopes of this curve at one degree intervals, or taking successive differences at each degree, a better acceleration curve can be derived. This approximate curve can only be used as a guide to indicate which direction the original acceleration values are to be shifted.

This method is particularly well suited for making small changes within the lift curve. Normally, changing any lift values or series of lift values disrupts the continuity of both the velocity and the acceleration curves, and bringing these curves into smooth alignment again is a chore. However, by shifting the acceleration values first as described here to produce the desired lift change, the velocity curve remains smooth and continuous at both ends of the change section.

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Tips and Techniques

Simplifying Mockups

"Paper doll" cutouts or replicas of machine parts such as links, levers or cams are often used to check the length of stroke, movements and clearances of moving machine parts. If the thumbtacks that are used for pivots are inserted from the bottom of a center-lined piece of file card and then taped to the drawing, the layout will not be ruined by large holes nor will holes be made in the drawing board.

The expense of using extra boards and extra time is saved when the original layout is used for this purpose.—EDWARD J. KICK, *Columbus-McKinnon Chain Corp., Tonawanda, N. Y.*

Calculating design constants of

Elastic Mounting Pads

. . . for equal static deflection when supporting a rigid flat plate at four points

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RIGID, flat loaded plates are often supported at four points on elastic mounting pads. It is sometimes rather difficult to calculate load reactions and mounting-pad design constants, particularly when the mounting points are nonsymmetrical and/or the load is not centered.

Presented here are working equations for calculating plate-support reactions and mounting-pad deflection, stiffness or area values for symmetrical or nonsymmetrical support points.

General Formulas: In Fig. 1 is a plan view of a rigid flat plate mounted on elastic supports at points 1, 2, 3 and 4 which support load W. The center of gravity of load W is defined by the distances a, b, and c in Fig. 1. The supports are assumed to have the same free length and rest on a rigid plane surface.

Let the stiffnesses of the supports 1, 2, 3 and 4 be k_1, k_2, k_3 and k_4 and the support reactions be P_1, P_2, P_3 and P_4, respectively.

Taking moments about lines A-A', B-B', and C-C', we obtain, respectively

$$P_3 a_3 + P_4 a_4 = Wa \quad (1)$$

$$P_2 b_2 + P_3 b_3 = Wb \quad (2)$$

$$P_1 c_1 + P_2 c_2 = Wc \quad (3)$$

The fourth equation is obtained by considering the consequences of the assumed rigidity of the

Nomenclature

A = Elastic mounting-pad area, sq in.
k = Stiffness of elastic mounting-pad, lb/in.
P = Load reactions at support point, lb
W = Weight of loaded plate, lb
Δ = Mounting-pad deflection, in.

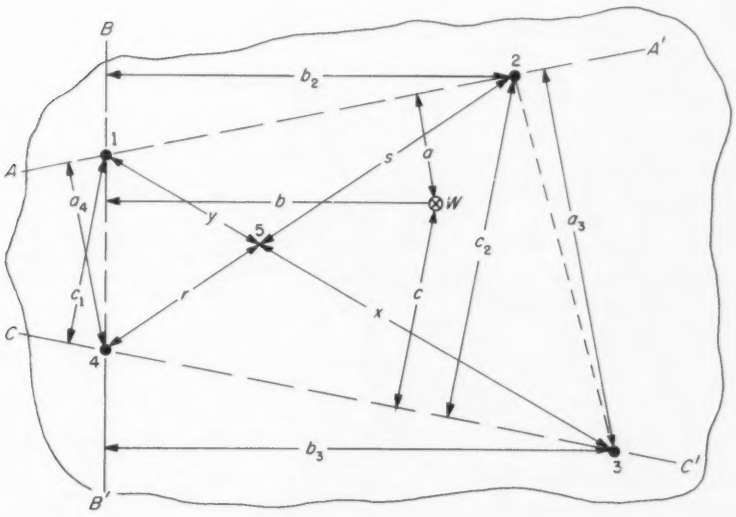


Fig. 1—Top view of rigid flat plate supported on elastic mounts at four nonsymmetrical points: 1, 2, 3 and 4. The load W is located at the center of gravity of the plate which is a distance from axis A-A', b distance from axis B-B', and c distance from axis C-C'.

plate. Diagonals from supports 1 to 3 and from 2 to 4 intersect at point 5 in Fig. 1. The deflection at point 5, Δ_5, is related to the deflections at points 1 and 3 by

$$\Delta_5 = \Delta_1 \frac{x}{x+y} + \Delta_3 \frac{y}{x+y} \quad (4)$$

and to the deflections at points 2 and 4 by

$$\Delta_5 = \Delta_2 \frac{r}{r+s} + \Delta_4 \frac{s}{r+s} \quad (5)$$

Let $D_1 = x/(x+y)$, $D_2 = r/(r+s)$, $D_3 = y/(x+y)$, and $D_4 = s/(r+s)$.

Since $\Delta = P/k$, setting Equations 4 and 5 equal, and substituting in the preceding D values, yields

$$\frac{P_1 D_1}{k_1} + \frac{P_3 D_3}{k_3} = \frac{P_2 D_2}{k_2} + \frac{P_4 D_4}{k_4} \quad (6)$$

Simultaneous solution of Equations 1, 2, 3 and 6 yields

$$P_1 = \frac{W}{c_1}\left(c - \frac{bc_2}{b_2}\right) + \frac{P_3 b_3 c_2}{b_2 c_1} \quad (7a)$$

$$P_2 = \frac{Wb}{b_2} - \frac{P_3 b_3}{b_2} \quad (7b)$$

$$P_3 = \frac{W\left[\frac{D_1}{k_1 c_1}\left(\frac{c_2 b}{b_2} - c\right) + \frac{D_2 b}{k_2 b_2} + \frac{D_4 a}{k_4 a_4}\right]}{\frac{D_1 b_3 c_2}{k_1 b_2 c_1} + \frac{D_2 b_3}{k_2 b_2} + \frac{D_3}{k_3} + \frac{D_4 a_3}{k_4 a_4}} \quad (7c)$$

$$P_4 = \frac{Wa}{a_4} - \frac{P_3 a_3}{b_4} \quad (7d)$$

If the supports are arranged in a rectangular pattern, Fig. 2, $D_1 = D_2 = D_3 = D_4 = \frac{1}{2}$. And $a = d_2 - d_1$, $b = e_1$, $c = d_1$, $a_3 = a_4 = d_2$, $b_2 = b_3 = e_2$, $c_1 = c_2 = d_2$. Under these conditions Equations 7*a*, *b*, *c* and *d* become

$$P_1 = W\left(\frac{d_1}{d_2} - \frac{e_1}{e_2}\right) + P_3$$

$$= \frac{W\left[\frac{d_1}{d_2}\left(\frac{k_4}{k_2} + \frac{k_4}{k_3}\right) - \frac{e_1}{e_2}\left(1 + \frac{k_4}{k_3}\right) + 1\right]}{1 + \frac{k_4}{k_1} + \frac{k_4}{k_2} + \frac{k_4}{k_3}} \quad (8a)$$

$$P_2 = \frac{We_1}{e_2} - P_3$$

$$= \frac{W\left[\frac{d_1}{d_2}\left(1 + \frac{k_4}{k_1}\right) + \frac{e_1}{e_2}\left(1 + \frac{k_4}{k_3}\right) - 1\right]}{1 + \frac{k_4}{k_1} + \frac{k_4}{k_2} + \frac{k_4}{k_3}} \quad (8b)$$

$$P_3 = \frac{W\left[\frac{e_1}{e_2}\left(\frac{k_4}{k_1} + \frac{k_4}{k_2}\right) - \frac{d_1}{d_2}\left(1 + \frac{k_4}{k_1}\right) + 1\right]}{1 + \frac{k_4}{k_1} + \frac{k_4}{k_2} + \frac{k_4}{k_3}} \quad (8c)$$

$$P_4 = W\left(1 - \frac{d_1}{d_2}\right) - P_3$$

$$= \frac{W\left[\frac{k_4}{k_1} + \frac{k_4}{k_2} + \frac{k_4}{k_3} - \frac{d_1}{d_2}\left(\frac{k_4}{k_2} + \frac{k_4}{k_3}\right) - \frac{e_1}{e_2}\left(\frac{k_4}{k_1} + \frac{k_4}{k_2}\right)\right]}{1 + \frac{k_4}{k_1} + \frac{k_4}{k_2} + \frac{k_4}{k_3}} \quad (8d)$$

Equal Stiffnesses: If the stiffnesses k_1, k_2, k_3 and k_4 of the supports are equal, Equations 8*a*, *b*, *c* and *d* for a rectangular pattern become

$$P_1 = \frac{W}{4}\left(\frac{2d_1}{d_2} - \frac{2e_1}{e_2} + 1\right) \quad (9a)$$

$$P_2 = \frac{W}{4}\left(\frac{2d_1}{d_2} + \frac{2e_1}{e_2} - 1\right) \quad (9b)$$

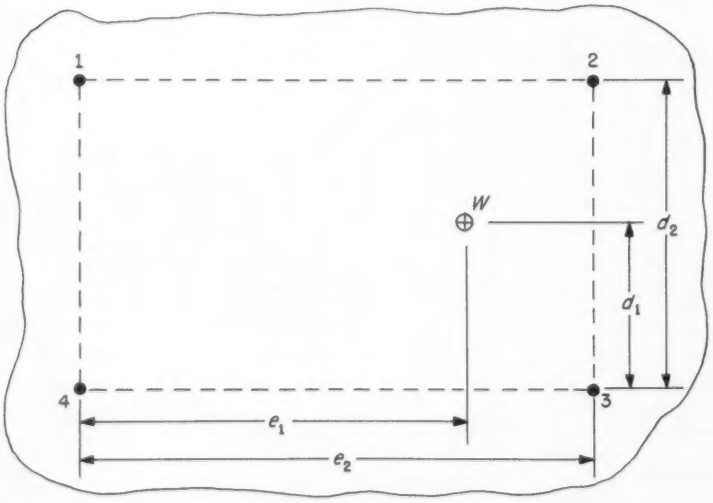


Fig. 2—Top view of a flat, rigid plate supported at four points arranged in a rectangular pattern.

$$P_3 = \frac{W}{4}\left(\frac{2e_1}{e_2} - \frac{2d_1}{d_2} + 1\right) \qquad (9c)$$

$$P_4 = \frac{W}{4}\left(3 - \frac{2d_1}{d_2} - \frac{2e_1}{e_2}\right) \qquad (9d)$$

Equal Deflections: If the deflection of each support is to be equal, then

$$\frac{P_1}{k_1} = \frac{P_2}{k_2} = \frac{P_3}{k_3} = \frac{P_4}{k_4} = \Delta \qquad (10)$$

This implies that the stiffnesses must be proportional to the reactions. The reactions in Equations 8*a*, *b*, *c* and *d* are functions of the stiffness ratios and not their absolute values. The equations that apply in the case of equal deflections can be obtained from Equations 8*a*, *b*, *c* and *d* by merely substituting k_1, k_2, k_3 and k_4 for the reactions P_1, P_2, P_3 and P_4, respectively. The simultaneous solution of these equations presents some difficulties. However, it is easy to show, by substitution, that Equations 9*a*, *b*, *c* and *d* are solutions of these equations. In other words, the loads for equal stiffnesses are identical with the loads for equal deflections. This fact simplifies the problem of designing supports for a plate which, in the loaded position, is to be parallel to its unloaded position. It is only necessary to calculate the reactions from Equations 9*a*, *b*, *c* and *d*, and then design supports, having the same free length, with stiffnesses proportional to the reactions.

Example: Consider a plate with supports in a rectangular pattern, Fig. 2. Let $W = 1000$ lb, $e_1 = 40$ in., $e_2 = 60$ in., $d_1 = 30$ in., and $d_2 = 40$ in. If the plate is to be mounted on rubber vibration-isolating pads, such as Isomode units made by MB Mfg. Co. for which the recommended pressure is 50 psi, find the area of the pads.

Since the support points are symmetrical, the load reactions at points 1, 2, 3 and 4 can be calculated from Equations 9*a*, *b*, *c* and *d*, or

$$P_1 = \frac{1000}{4}\left[2\left(\frac{30}{40}\right) - 2\left(\frac{40}{60}\right) + 1\right] =$$

292.5 lb

$$P_2 = \frac{1000}{4}\left[2\left(\frac{30}{40}\right) + 2\left(\frac{40}{60}\right) - 1\right] =$$

457.5 lb

$$P_3 = \frac{1000}{4}\left[2\left(\frac{40}{60}\right) - 2\left(\frac{30}{40}\right) + 1\right] =$$

207.5 lb

$$P_4 = \frac{1000}{4}\left[3 - 2\left(\frac{30}{40}\right) - 2\left(\frac{40}{60}\right)\right] =$$

42.5 lb

Using these values of P_1, P_2, P_3 and P_4,

$$A_1 = \frac{292.5}{50} = 5.85 \text{ sq in.}$$

$$A_2 = \frac{457.5}{50} = 9.15 \text{ sq in.}$$

$$A_3 = \frac{207.5}{50} = 4.15 \text{ sq in.}$$

$$A_4 = \frac{42.5}{50} = 0.85 \text{ sq in.}$$

where A_1, A_2, A_3 and A_4 are the areas of the pads at support points 1, 2, 3 and 4, respectively. With these pad areas the loaded plate will be parallel to its unloaded position, i.e. deflection is equal at all support points.

If a specific amount of deflection were required, it would be necessary to calculate values of k_1, k_2, k_3 and k_4 from Equation 10. For a $\Delta = 0.5$-in.,

$k_1 = 292.5/0.5 = 585$ lb/in.

$k_2 = 457.5/0.5 = 915$ lb/in.

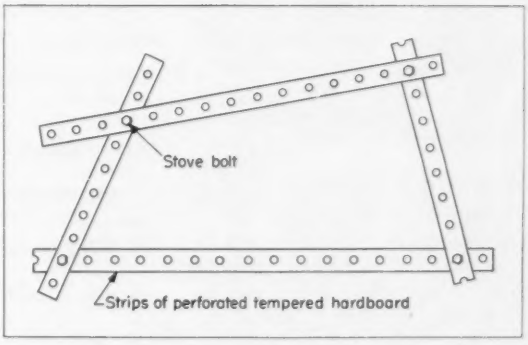
$k_3 = 207.5/0.5 = 415$ lb/in.

$k_4 = 42.5/0.5 = 85$ lb/in.

If pads were used that had these stiffness values, a 0.5-in. deflection at all four points would be produced.

Tips and Techniques

Linkage Layout



Picturing the relative and absolute motion of links in a mechanism can be difficult. For this reason, it is common practice to resort to mockups made from paper, cardboard, etc. If any quantity of such work is done, an inexpensive, easily assembled, and durable set of links can be made by cutting strips from perforated tempered hardboard. Joint pins can be 3/16-in. stove bolts. Since the hole spacing in the board is quite accurate, variations in dimensions of the links can be made quickly and easily. If one member of the mechanism is to be held fast, tape may be used to fasten it to any suitable surface.—H. G. LAUGHLIN and A. R. HOLOWENKO, *Purdue U., Lafayette, Ind.*

DESIGN ABSTRACTS

Characteristics and applications of **Rotary**

Gear, vane, and piston pumps are most commonly used for hydraulic power purposes. Gear and vane pumps are also used for lubrication, fuel transfer and special-purpose applications. Piston pumps are capable of delivering high pressures and are more efficient over a wide range of speed and pressure than other pump types.

This abstract presents general design features of various pump types, their operating principles, relative efficiencies, and applications.

HYDRAULIC pumps are generally divided into three basic categories: Rotodynamic, reciprocating and rotary. Rotodynamic types are centrifugal or axial-flow pumps designed to develop fluid pressure and impart energy to a fluid through acceleration and fluid dynamic force. These pumps provide smooth and constant-delivery flow under a given set of conditions, delivery varying significantly with changes in discharge pressure.

Reciprocating and rotary pumps are classified as self-priming positive-displacement pumps in which rate of delivery is related almost entirely to operating speed, and is affected only slightly by pressure.

The mechanism of a positive-displacement pump is so arranged that movement of parts creates an expanding fluid chamber which induces suction of fluid into the chamber and a contracting chamber which causes fluid to be expelled through the discharge port. A definite geometrically calculable volume is exposed to every pumping cycle of the mechanism.

Rotary pumps provide positive displacement through a variety of designs which contributes to a smoother output performance than obtainable in a reciprocating-type pump. Rate of discharge is directly proportional to speed of rotation. It is also characteristic of positive-displacement pumps to continue pumping against a higher pressure head until structural failure occurs or until torque capacity of the driving motor is developed. For this reason, pressure-relief valves are usually required either in the pump or in the hydraulic system.

When such a pump is subjected to increased speed, and resultant increase in flow is undesirable, bypass valving is commonly used to divert excess flow. Delivery rate

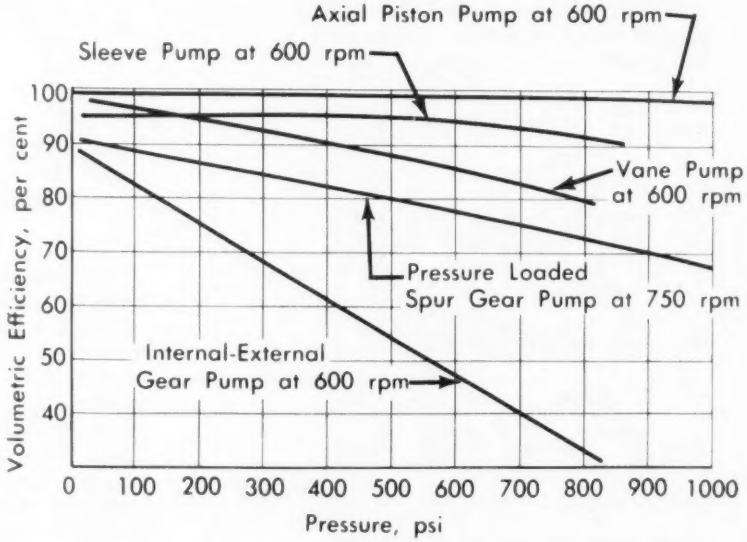
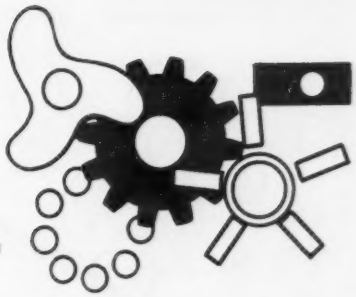


Fig. 1—Volumetric efficiency comparison of different pump types. As shown, axial piston pumps have the highest volumetric efficiency and maintain it most steadily over a wide range of pressures.



Positive-Displacement Pumps

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Chief Engineer, Project Engineer
Hydraulic Products Div.
Thompson Products Inc.
Cleveland, Ohio

can also be reduced by bleeding fluid from the discharge side to the suction side of the pump. Variable-volume or variable-displacement features are sometimes used to provide constant pressure, constant flow or other desired performance characteristics.

Efficiency: Overall efficiency of a positive-displacement pump is basically a function of mechanical and volumetric efficiencies. Friction of moving parts absorbs power so that not all of the power supplied is available to the fluid being pumped. Ratio of actual power expended on a fluid to power supplied to the pump defines mechanical efficiency.

If pump clearances are too small, or if parts are not sufficiently lubricated, high friction losses occur, resulting in low mechanical efficiency. Internal clearances cannot be excessively large or there will be considerable leakage from high-pressure to low-pressure sections, and the pump will operate inefficiently, if at all.

Theoretical delivery rate of a positive-displacement pump can be calculated readily from significant dimensions. Ratio of actual delivered volume to calculated theoretical volume is volumetric efficiency. Fig. 1 compares volumetric efficiency data of several different types of positive displacement pumps described in this article.

In pumps of poor design, fluid temperature rises excessively, lowering viscosity and increasing leakage through close-fitting parts. This may initiate a continuous cycle in which increased leakage raises temperature and lowers viscosity still further, until the oil can no longer maintain a lubricating film and damaging seizing or galling occurs.

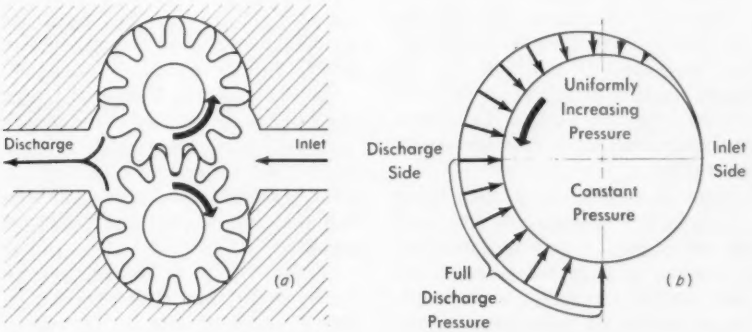


Fig. 2—Spur-gear pump design, *a*, capable of output pressures up to 800 psi. Inlet fluid is carried around the periphery of gears which accurately fit the housing bore diameter. Meshing teeth form a line-contact seal which prevents return of oil to the suction side of the pump. Uneven pressure distribution within the spur gear pump, *b*, is caused by individual pressure drops from one tooth space to the next.

Spur Gear Pumps: The straight spur-gear comprises a pair of engaged spur gears rotating in a housing, Fig. 2*a*. Oil enters one side of the pump, is carried around the periphery of the gears in spaces between the teeth, and is discharged from the other side. Meshing teeth form a line-contact seal that prevents oil from returning

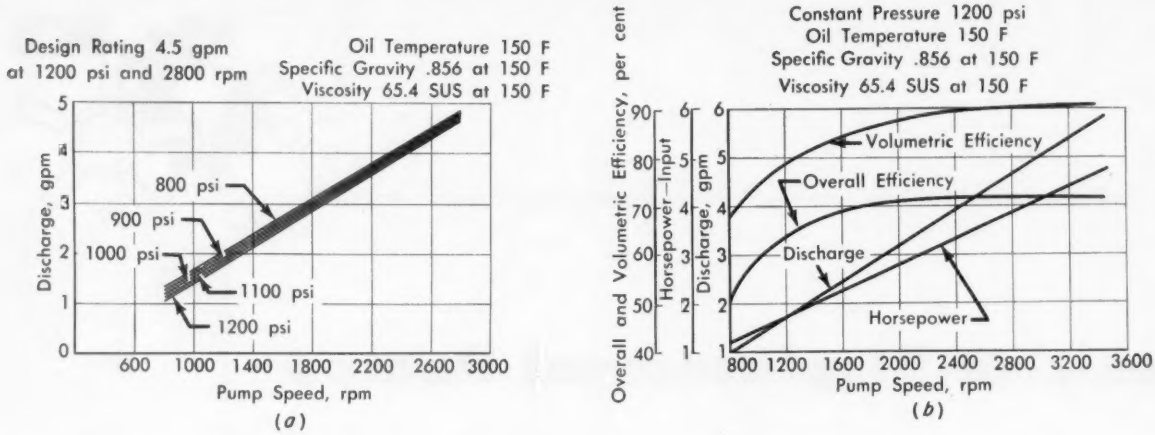


Fig. 3—Delivery curves of a pressure-loaded spur gear pump, *a*. Pressure-loading features, designed into the pump, effectively balance force differentials normally encountered between inlet and discharge areas. General performance characteristics of a pressure-loaded gear pump operating at 1200 psi are shown at *b*.

from the pressure side to the suction side of the pump.

This type of pump is economical, rugged and dependable, and is capable of delivering pressures up to 800 psi. Refinements are frequently made to the basic design to improve efficiency and operating characteristics.

Three main running clearances are characteristics of a spur-gear pump.

1. End-face clearance between gear end-faces and pump housing.
2. Radial clearance between gear-teeth tips and pump housing.
3. Tooth-contact clearance as a result of runout or nonparallel shafts.

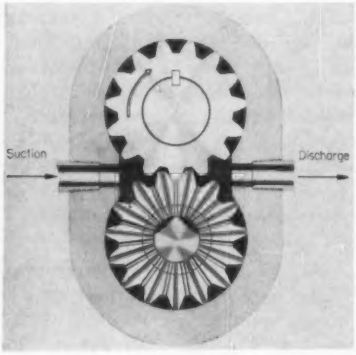


Fig. 4—Spur gear pump with relief holes in the driven gear. Trapped fluid is bypassed through the holes to relieve pressure in tooth spaces. This design feature provides nearly perfect sealing between suction and discharge sides.

These clearances are all fluid leakage paths and are listed in order of relative importance. How closely these clearances are controlled actually determines efficiency of the pump.

Because of the pressure-drop from one tooth space to the next, an uneven distribution of pressure occurs within a spur-gear pump, Fig. 2*b*.

A pressure balance designed into the pump provides uniform sealing between end plates and gear faces and contributes to long pump life. Efficiency characteristics, especially at high pressures and low speeds, are improved by pressure loading the end plates. A typical volumetric efficiency relationship at various pressures for pressure-loaded pumps is indicated by the close relative positions of delivery curves, Fig. 3*a*. Other high-pressure performance curves are shown in Fig. 3*b*.

One limitation of a spur gear pump is low volumetric efficiency at low speeds. This is somewhat overcome in a pressure-loaded design but still remains a limitation when compared with other types of pumps. Another limitation in some cases is operation noise. Many improvements have been made to reduce noise level in these pumps, but over wide speed and pressure ranges the noise problem is apparent by comparison with other pump types.

Pressure considerations are normally from 800 psi for nonpressure-loaded units to 2000 psi for pressure-loaded designs. These are approximate values which vary with construction and materials and also with speed and type of operation.

Spur-gear pumps are widely used in installations for hydraulic implement actuation systems. These systems require large capacity for heavy duty operation and large quantities of oil for flow, i.e., from 5 to 15 gpm. The pump must also be able to maintain a predetermined pressure over an extended time period when a load is suspended. The spur-gear pump is capable of such performance, including handling of a large volume of oil for its size.

In the pump in Fig. 4, the gear teeth have a special shape which enables them to bottom and completely fill the mating tooth spaces, thus providing nearly perfect sealing between suction and discharge sides.

Trapped fluid is forced through tooth holes into chambers cut in the gear shaft and is ultimately forced out through holes in adjacent teeth to the discharge side of the pump. A chamber in the shaft toward the suction side allows fluid to be drawn through

radial holes into tooth spaces before they are open to fluid on the inlet side.

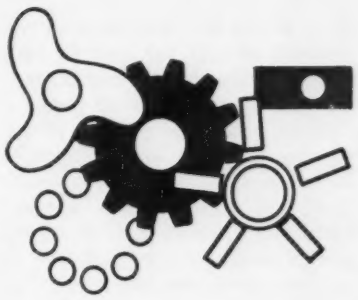
By rotating the shaft slightly so that one of the directing chambers connects some of the radial holes on both inlet and outlet sides of the pump, a predetermined amount of fluid may be returned from discharge to suction side. This provides a means of varying rate of discharge from a normally constant-volume pump.

External-Internal Gear Pumps: The external-internal gear pump is another constant-volume type pump comprising a ring gear and pinion, Fig. 5, fitted into a housing. Pumping action is similar to that in a spur gear pump. As the teeth separate during rotation, they create a void into which oil flows from a connecting port or suction cavity. Both gears carry oil around their peripheries, and as the teeth again come into mesh, oil is forced into a discharge port or cavity.

Pumping action in a Pigott gear pump is similar to that in an involute tooth external-internal gear pump, except that continuous tooth contact, instead of a crescent, is depended upon to separate suction and discharge sides.

One of the advantages of the external-internal gear pump is its adaptability to installation where the drive shaft extends through the case to serve other purposes. Installation in automatic transmissions is an example of an application which takes advantage of this feature. Utilizing the radial porting feature, the external-internal gear pump may be used as a combination of many gear sets running from a common shaft, forming a multiple-stage pump operating many units and requiring almost unbelievably small linear space for the entire unit.

The external-internal gear pump is a more practical unit for low-volume flow than for high-volume output because capacity is a function of diameter. Large-volume



flow requirements necessitate large-diameter pumps, in which shaft speeds must necessarily be limited to avoid high surface speeds and danger of galling or seizing.

Volumetric efficiency of an external-internal gear pump is governed by end-face clearance and also by crescent clearance in the involute-tooth design, or tooth-tip clearance in the Pigott design. With optimum end-face clearance, the Pigott gear pump, having more

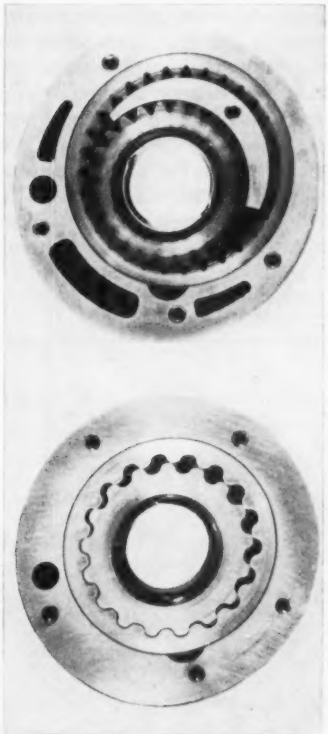


Fig. 5—Characteristics of external-internal type gear pumps. Involute gear pump, top, uses a crescent to isolate inlet and outlet sections. Pigott type pump, bottom, does not require a crescent since teeth of inner pinion and outer ring gears are in continuous contact.

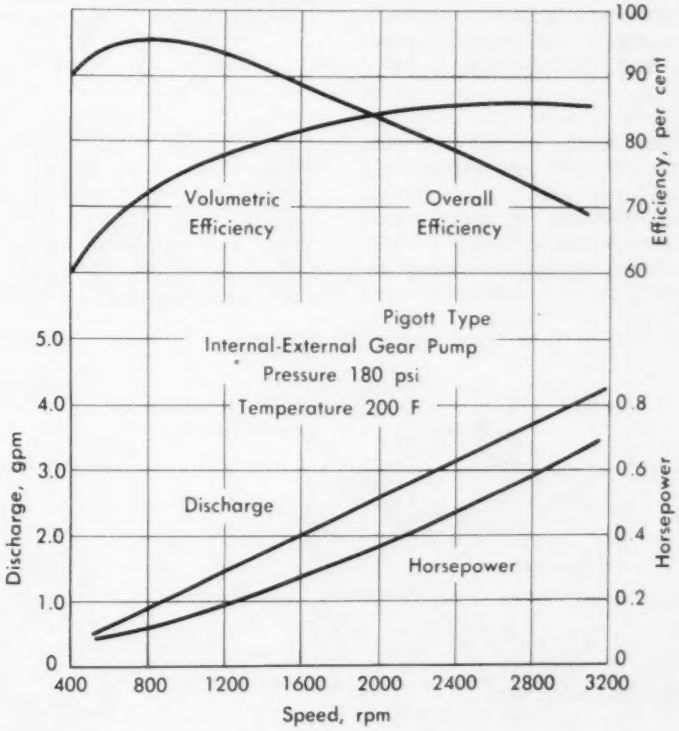


Fig. 6—Performance characteristics of a Pigott type external-internal gear pump operating at 180 psi. This type of pump usually has greater volumetric efficiency in low-speed ranges than the involute-tooth pump. In the Pigott gear type of pump, the pinion has one less tooth than the ring gear and advances one tooth during each revolution. Consequently, relative speed between the two rotors is small and wear slight. Gears are usually of hardened steel in a cast-iron housing.

teeth in contact and without the crescent, usually has greater volumetric efficiency in low-speed ranges than the involute-tooth pump.

External-internal gear pumps are also sensitive to dirt particles in the system and are generally inefficient volumetrically at low speeds and high pressures. They have a relatively low noise level in medium speed and pressure ranges. Characteristic curves of an external-internal hydraulic pump are shown in Fig. 6.

This type of pump is used almost universally in automatic transmission applications. It is also ideal as a lubricating pump for large engines since it can be installed around a driveshaft.

Lobe Pumps: The three-lobe rotary pump operates in a manner similar to a gear pump except that fluid is delivered in a fewer number of larger volume quantities. Therefore, relative flow from this type of pump is not as constant as compared to a gear pump. During operation, one lobe drives the other and together form a fluid-tight contact at the center. Fluid trapped in pockets formed by the lobes and casing is carried around and forced out the discharge.

Vane Pumps: A simple vane pump is illustrated in Fig. 7. The rotor contains sliding vanes or blades that are free to move outward against an eccentric housing. Spaces between adjacent vanes expand on the suction side, filling with oil, and contract on the discharge side, forcing oil through the discharge port.

The cavity in the vane pump is shaped so that radial movement of vanes is prevented except in positions where pressure is equal on both sides of the vane, i.e., when the vane is exposed to either the suction or discharge port. Between ports, the small radius on one side and the large radius on the other are constant. No movement occurs when friction load on the vanes is high, thus minimizing friction power-loss and improving pump efficiency. This design is frequently used as an aircraft fuel pump and also as an automotive refrigeration compressor.

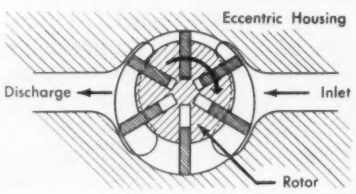


Fig. 7—Simple vane-pump design. Vanes are free to slide radially. Spaces between vanes expand during the suction cycle and contract during the discharge cycle. This design is frequently used as a fuel pump and refrigeration compressor since relatively high efficiencies and outputs are possible for the small space required.

Vane pumps generally have high efficiency and relatively high output for the small space occupied. They are tolerant of dirt particles in the system and are characterized by low noise level. They have long life, and wear has little effect on operation over a long period of time.

Applications of vane pumps include lift systems, machine tools, automotive power steering, aircraft fuel pumps, lift trucks and automatic transmissions.

Plunger Pumps: Rotary plunger or piston pumps are built in a variety of shapes and sizes, but basically are either radial or axial in principle. These may be constant-volume or variable-volume pumps, but most radial plunger pumps are designed for variable displacement.

In the plunger pump, a piston or other type of plunger moves linearly in a bore while the body containing the bore rotates, exposing the open end of the bore alternately to suction and discharge ports. When the bore is in the vicinity of the suction port, the piston moves away from the port and oil is forced in. As the bore end comes into the vicinity of the discharge port, the piston moves in the opposite direction and forces oil out the discharge port. Generally speaking, all plunger pumps are relatively large for a given displacement volume.

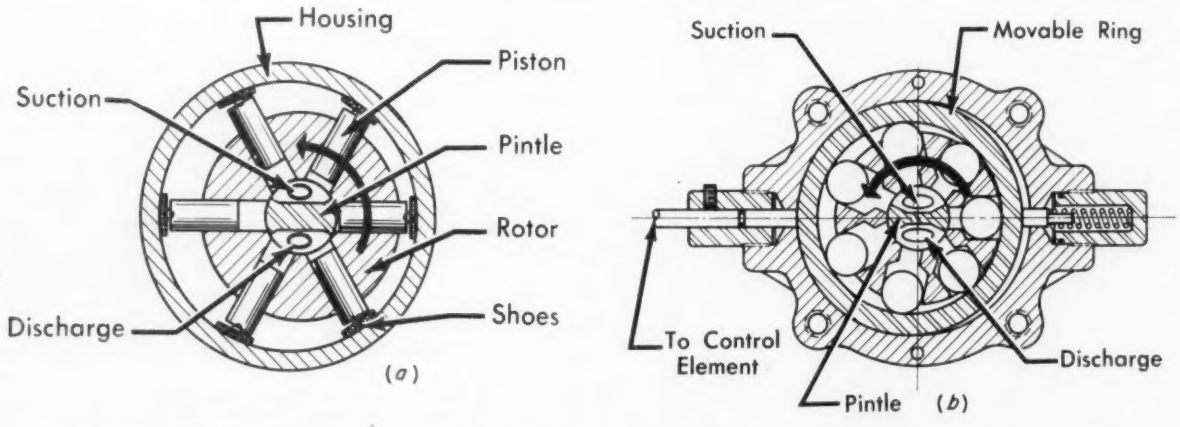


Fig. 8—Radial piston pump, *a*. Pistons are located in a rotating cylinder block and follow an eccentric path which may be varied to change pumping stroke and pump output. In the ball-type plunger pump, *b*, pumping stroke and output are varied by varying eccentricity of the movable ring. A pressure-sensing device senses system pressure and adjusts eccentricity to keep system pressure at operating requirements. This type of pump is applicable to central power applications which require a pump capable of pressures from 0 to 1000 psi.

Piston pumps characteristically have good slow-speed pumping characteristics, and are also capable of high-pressure operation from 5000 psi and up, limited in many cases only by structural strength of the parts. High volumetric efficiencies are possible.

Radial Plunger Pumps: Most radial plunger pumps are, in effect, piston pumps in which pistons are located in a rotating cylinder block and follow an eccentric path that causes them to reciprocate in the bores, Fig. 8*a*. By constructing the pump so that an eccentric ring may be adjusted laterally, variable displacement is achieved. A radial-plunger type pump that utilizes balls instead of conventional cylindrical pistons is shown in Fig. 8*b*. The length of seal is only a line contact and is not conducive to high volumetric efficiency unless close fits are maintained.

This design illustrates the ease with which a radial-type pump may be adapted to variable-volume operation. The ring within the housing is positioned eccentrically by two diametrically opposed pins that can be moved by a pressure-sensing or flow-control element or any other type of control to change eccentricity and output of the pump.

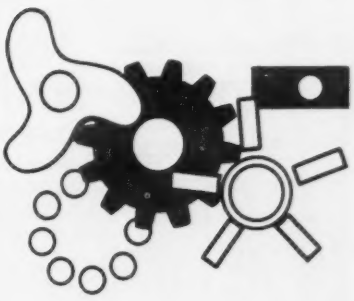
This type of ball pump is applicable in central power applications in hydraulic systems which require a pump of variable speeds and pressures ranging from practically 0 to approximately 1000 psi.

Axial Piston Pumps: The axial-type pump, Fig. 9*a*, is an example of a pressure-balanced piston pump. It also illustrates compactness in design and small space requirements as compared to a radial-type pump.

Pistons are forced to reciprocate while rotating ports expose each bore to the discharge opening on the forward stroke of the piston and to the suction port during the piston's return stroke. Discharged fluid flows into an annular cavity from which it may be delivered in any direction.

Construction of this pump converts loads into almost pure thrust force distributed uniformly around the inner race of the bearing, resulting in long bearing life and materially increasing pressure capacity of the pump. A characteristic of piston pumps is the relatively constant volumetric efficiencies maintained over a wide range of pressures. Low-speed volumetric efficiency is relatively more constant than high-speed efficiency.

An axial pump that lends itself readily to either variable or constant-volume design is the pump shown in Fig. 9*b*. If the angle of the cylinder block is fixed, the pump is a constant-volume pump. If the cylinder block is contained in a yoke pivoted on bearings so that the angle can be changed, it becomes a variable-volume pump.



When the angle is zero, displacement becomes zero. If the yoke is moved beyond the center to an angular position on the opposite side, flow is reversed. This change in oil flow takes place without need for special valving. Flow reversals may be made at rated pressures, or delivery may be reduced to zero while rated pressure is maintained at either port.

Like other piston pumps, this type of pump demonstrates high efficiency and sustains high performance at high pressures and speeds. Fig. 10 shows performance curves for this pump at 100 and 1000 psi.

Sleeve Pumps: Power-assisted steering systems are among the newest applications of hydraulic power which, until recently, was derived from spur gear, vane or external-internal gear pumps. A new and different pump designed

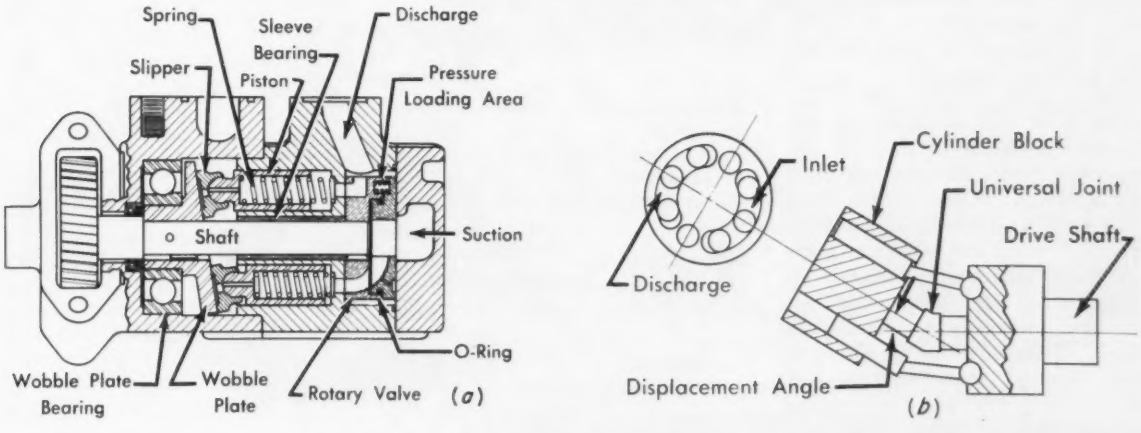


Fig. 9—Axial piston pump, *a*. Compact design and small space requirement are characteristic of this type of pump. Loads are distributed uniformly around the inner race of the bearing by the wobble plate rigidly fixed to the shaft. This construction increases bearing life and pressure capacity of the pump. Offset axial-piston pump, *b*, is a constant-volume pump when angle between cylinder block and driveshaft is fixed. By varying angle, flow reversals may be made at rated pressures, or delivery may be reduced to zero while maintaining rated pressure at either port.

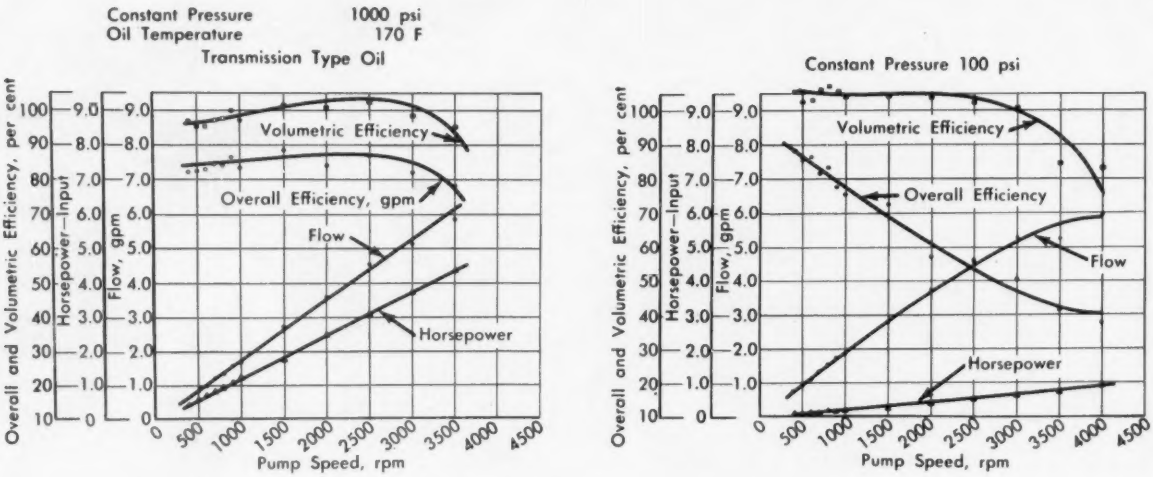


Fig. 10—Performance characteristics of the axial piston pump operating at 1000 psi, left, and 100 psi, right. Curves indicate that a piston pump is volumetrically efficient at both high and low pressures.

and developed for this purpose has the appearance of an axial piston pump, but actually utilizes sleeves instead of pistons, Fig. 11.

The pumping mechanism is composed of two cylinder blocks and a set of nine hollow sleeves. The assembly of sleeves and cylinder blocks forms a series of tubular chambers consisting of the passage through the sleeve and the cavities at the ends of the sleeves. While available volume in a cylinder bore is increased during one half-revolution, a suction port is exposed and fluid is drawn into the bore. During the second half-revolution, while volume in a given bore is decreasing, a discharge port is exposed in one cap and fluid is forced out.

This pump operates at a low noise level and is capable of delivering pressures of 2000 psi and up. Volumetric efficiency is high, as is overall efficiency. The pump has very good low-speed pumping characteristics and maintains high-pressures and high volumetric efficiencies at very low speeds; yet it has practically no high-speed limit. Since extreme precision is not required, manufacturing cost is relatively low, and free running clearances and lack of radial loads contribute to long pump life.

With suction and discharge ports available at both ends of the pumping mechanism, the sleeve pump may be designed for a variety of positions of outlet and inlet connections. This type of pump is most suitable in power-steering applications, central hydraulic systems, high-pressure water systems and hydraulic lift systems. It is not suitable as a hydraulic motor because of high breakaway torque caused by pressure-loading.

In the sleeve-type pump, a combination flow-control and pressure-relief valve is designed into the pump to allow a predetermined rate of discharge at all speeds and pressures, excess oil being bypassed within the pump. Flow from the valve outlet into the system is limited to a selected rate and will remain constant at that rate.

Characteristic curves of sleeve type pumps without flow control are shown in Fig. 12, left, and with flow control, Fig. 12, right.

Hydraulic Motors: Most fluid

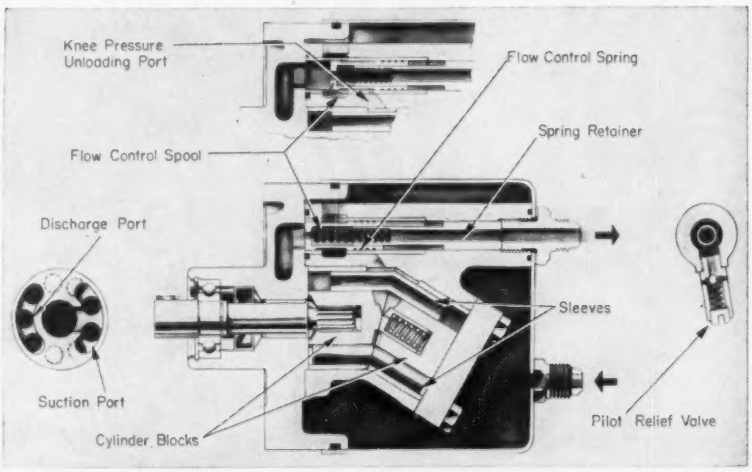


Fig. 11—Sleeve-type hydraulic pump with flow control and pressure-relief valve. As one sleeve block is rotated by the drive shaft, sleeves act as connecting links to rotate the other block. This new pump was designed specifically for power-assisted hydraulic systems, and is capable of delivering high pressures from 2000 psi.

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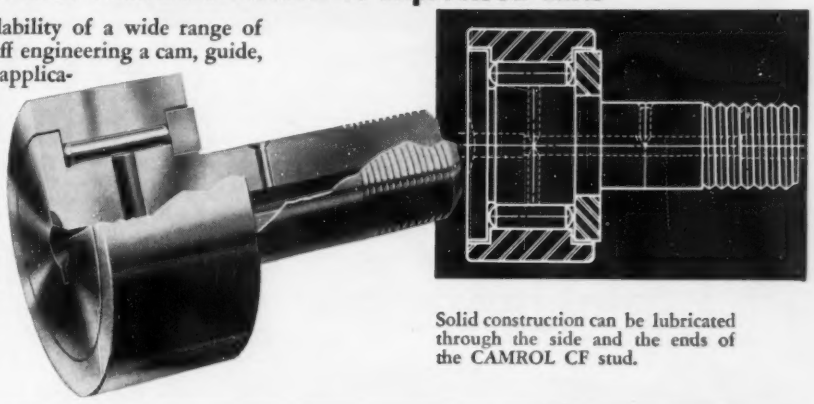

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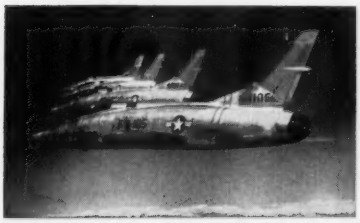
YR bearings help F-100 Super Sabre make slower and safer landing

The supersonic speeds obtained by today's modern aircraft set up design problems not encountered with older, slower planes. The overall streamlined design required for speed in flight, for instance, necessitated finding ways of supporting the North American F-100 Super Sabre at low air speeds required for landing. A



series of slats on the leading edge of the wing, providing greater lift at lower air speed, was the answer. Each slat is supported by McGill CAMROL YR bearings — especially designed to permit shaft or yoke mounting. These long-life bearings carry the loads of these slats as they move on tracks during flight of the Supersonic F-100.

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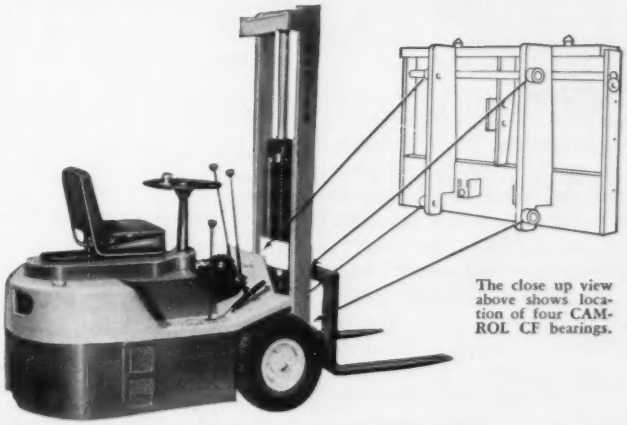

The close up view above shows location of four CAMROL CF bearings.

Small size and high load-carrying unit construction with simplified lubrication are among principal benefits obtained by Hyster Company from use of CAMROL CF bearings as fork support rollers in its Hyster 20 and other lift trucks.

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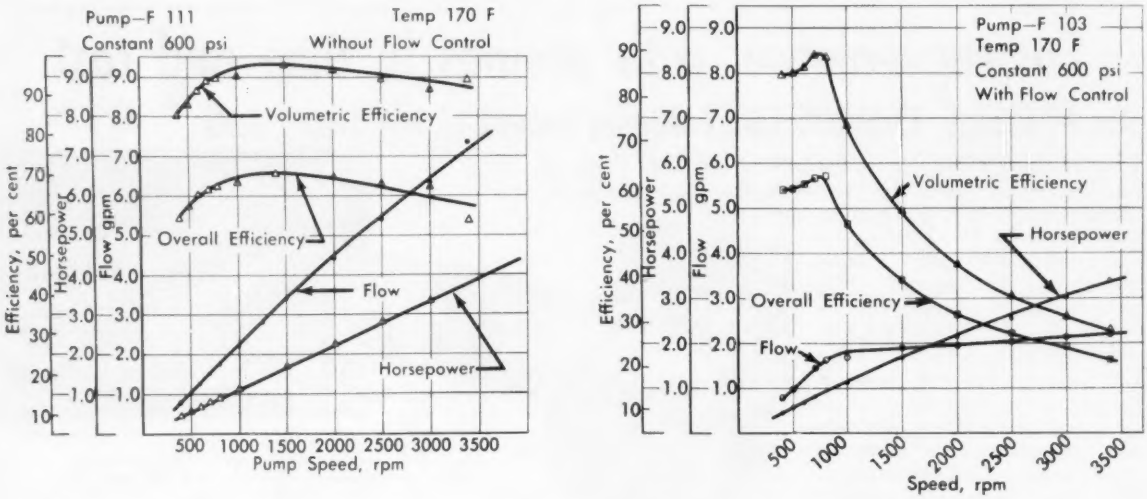


Fig. 12—Performance characteristics of basic sleeve pump without flow control at 600 psi, left, and with flow control valving at 600 psi, right. Good low-speed pumping characteristics are evident, although this pump has practically no high-speed limit.

pumps can be used as fluid motors simply by admitting fluid under pressure to one port and discharging it from the opposite port.

Chief use of a hydraulic motor is to develop torque, either for driving a mechanism or for decelerating as in a brake. Actually, it often must do both. Low inertia, low frictional resistance and ability to stall without failure are desirable features of a hydraulic motor. Generally, high volumetric efficiency indicates a desirable pump mechanism, whereas high mechanical efficiency indicates a desirable motor mechanism. Speed and pressure conditions are important considerations in determining the most suitable design for a particular application.

Gear pumps and plunger pumps are the types most widely used as hydraulic motors. Axial-piston designs have high volumetric and mechanical efficiency which makes them suitable for use as both. The ball-type pump shown in Fig. 8*b*, when operated as a fluid motor, has a series of characteristic curves as shown in Fig. 13.

Some pumps are not as applicable as hydraulic motors. In a pressure-loaded pump for example, braking effect of the end plate causes a high break-away torque. Thus, the feature that makes this an efficient pump is a detriment to it as a motor.

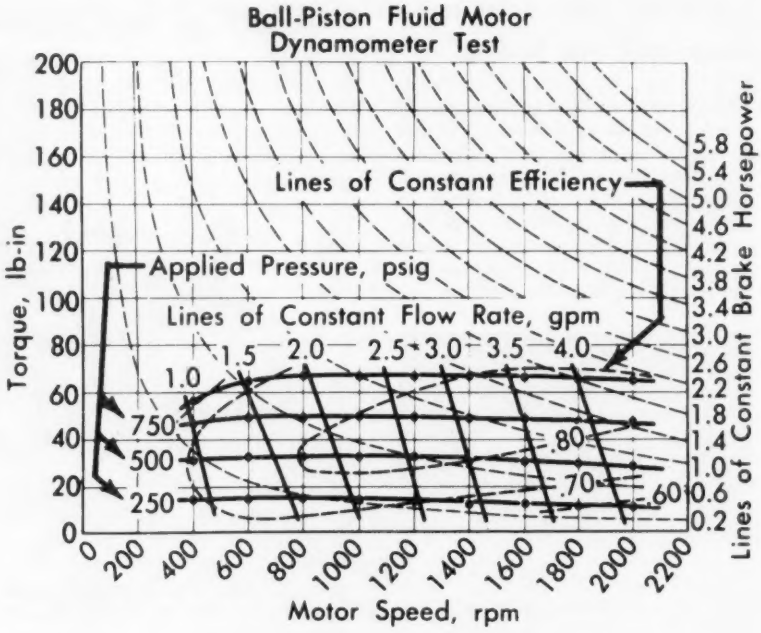
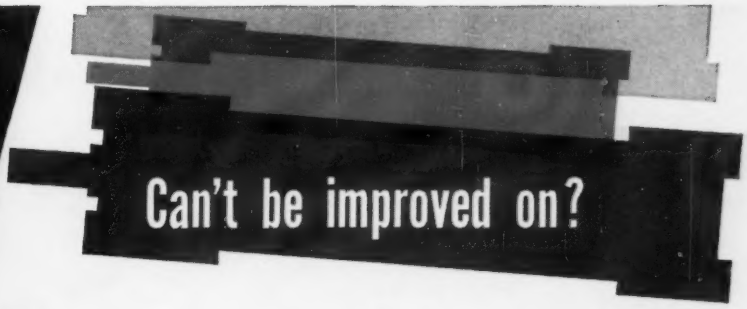


Fig. 13—Performance characteristics of a ball plunger pump when operated as a fluid motor.

Unless specifically constructed for the purpose, a simple gear pump such as that illustrated in Fig. 2 is not suitable as a fluid motor because unbalanced pressure tends to bind the gears against the housing.

From "Design Features, Characteristics and Applications of Rotary Positive Displacement Pumps" in Thompson Products Engineering Bulletin, *July*, 1957.



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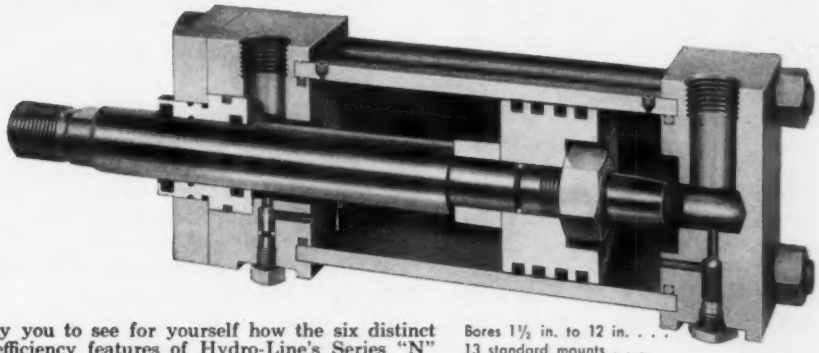

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Dry-Film Lubricants

By MAJ. W. C. HART and B. RUBIN
Materials Laboratory
Wright Air Development Center

Most successful types of dry-film lubricants have excellent extreme-pressure properties and good anti-wear properties for plain bearing application at low speeds

BONDED dry-film lubricants can successfully supplement or replace wet lubricants in low-speed sliding applications and plain bearing surfaces subject to intermittent operation. In these applications, loads are usually low except where motion of the component is slight. Frequently, oil or grease is used in conjunction with dry lubricant. The dry film aids break-in of rubbing surfaces and prolongs part life. The wet film affords a measure of corrosion prevention.

Use of dry films must be limited to applications in which safety is not directly affected by failure of the film. Applications considered satisfactory for dry-film lubricants include:

1. Unprotected sliding surfaces where wet lubricants collect dust and grit.
2. Plain bushings and valves where temperatures prohibit grease.
3. Hinges, latches, and pin linkages.
4. Acme-threaded drives.
5. Bronze oil seals.
6. Self-aligning rod-end bearings (particularly for high temperature.)
7. Bearings of retracting joints and torque joints.
8. Slider-track combinations replacing rollers.

Criteria to aid in choice of dry lubricants should include their friction-reducing properties, life expectancy, ease of application, and susceptibility to dirt pick-up.

Some general categories of dry-film coatings are:

1. Baked resin-bonded films containing graphite or molybdenum disulfide.
2. Baked resin-bonded films containing molybdenum disulfide with resin bases of corn syrup, glycerol, silicone, or asphalt.
3. Pressurized-spray can coatings containing graphite or molybdenum disulfide in a volatile carrier.
4. Air-drying coatings applied by dipping.

Corn syrup and glycerol-base resins are superior to silicone and asphalt-base resins. The wide-spread difference does not represent a basic difference in the molybdenum disulfide-resin friction and endurance life, but rather differences in adhesion of these films to the base metal surface. There is also a great difference in endurance life when running a bare metal surface against a coated surface as compared to running film against film, Fig. 1 Endurance of film life, for film-to-metal rubbing, is the same whether the film is applied to static or rotating surfaces.

Air-drying coatings sprayed onto a surface directly from a container, or applied by dipping or brushing, are desirable from the viewpoint of initial application and periodic reapplication. For equivalent film thickness, baked films give longer life than air-dried films. Films containing molybdenum disulfide are more effective than films containing graphite. Extreme-pressure properties of dry films are excellent.

From "Evaluation of Dry-Film Lubricant Coatings," Part 1, Office of Technical Services Report PB 121922, WADC TR 53-466.

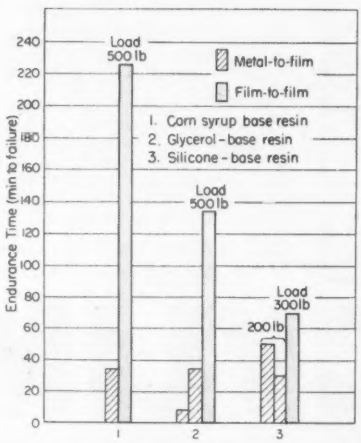

Fig. 1—Endurance life of metal-to-film and film-to-film surfaces. Films contain molybdenum disulfide in resin base.

Titanium vs Steel Alloys For High-Temperature Structures

Confusion concerning relative merits of various steel and titanium alloys has been caused more by a lack of understanding of application than by disagreement in basic knowledge.

DUE to influence of configuration and design environment, it is possible for titanium alloys to be optimum for one design and steel alloys to be optimum for another, even though both designs have the same maximum capability. A study to compare material efficiency should be related to a specific design.

Selection of material involves evaluation of structural efficiency, availability and cost of material, manufacturing facilities requirements and customer maintenance problems.

Of the newer titanium alloys, 16 V, 2.5 Al will be available in production quantities in the near future. This alloy has a higher strength/weight ratio than 12 Cr steel at 600 F. Alloy 6 Al, 4 V is representative of high-strength titanium alloys currently available. On a strength/weight basis, 6 Al, 4 V has approximately a 35 per cent weight advantage over 12 Cr steel at room temperature. At approximately 600 F, the two materials are of equal efficiency. Above 600 F, 12 Cr steel has a slight ad-

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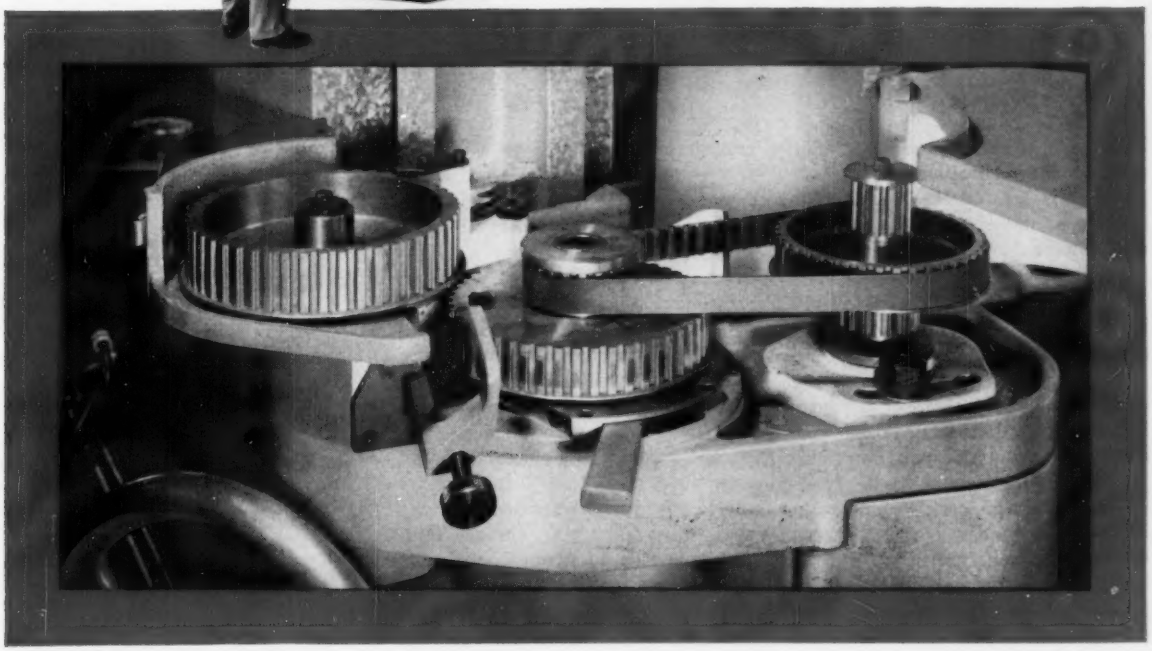

In keeping with its embodiment of the latest engineering advances, this Pratt & Whitney machine uses Gilmer "Timing" ® Belts to drive the spindle at constant angular velocities, assuring the finest finishes and maximum tool life. Belts can be changed readily to any of three positions, in the manner of change gears, to provide various spindle speed ranges, permitting use of either High Speed Steel or carbide mills and small diameter grinding wheels.

The design engineer for Pratt & Whitney states, "From the very concept of this machine the Gilmer 'Timing' Belt principle was selected, and has proved to be a wise selection giving trouble-free power transfer throughout the exceptionally wide spindle speed range of 48 rpm to 11,500 rpm. The belts are used to insure positive drive with absolutely no slip and vibrationless operation of the spindle."

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Circle 492 on page 19

vantage. Many designs capable of operating in a 600 F environment are actually critical at room temperature conditions and the strength/weight ratios at room temperature may be much more important than the 600 F strength/weight ratios.

At 1000 F, both titanium and steel lose efficiency rapidly. For structures designed for temperatures of 1200 F and above, the Inconels and molybdenum materials will play a dominant role. The material transition in the future will not be from titanium to steel, but rather from the titanium and steels to the Inconels and molys.

From IAS preprint 731 entitled "The Selection of Structural Materials for Supersonic Flight," presented at the National Summer Meeting of IAS in Los Angeles, June, 1957, by Donald D. Cox, Boeing Aircraft Co., Seattle.

Friction-Seal Materials

for high-speed operation

By PETER F. MATAICH
Horizons Inc.
Cleveland, Ohio

New seal materials are being developed for operation at 1000 F and 30,000 fpm surface speed with life expectancies of 1000 hr without measurable deterioration

UNDER usual operating conditions in machines, rubbing speeds and temperatures to which friction seals are subjected are sufficiently moderate so that wear is uniform and gradual. Under severe conditions of speed or temperature, wear ceases to be gradual and uniform, and becomes exaggerated, violent, and erratic. Galling and scuffing occur, resulting in general roughening and appreciable loss of material.

Tendency to gall can be reduced considerably by choosing hard mating materials for both surfaces to give as small a true area of contact as possible. Mating materials should be chemically dissimilar to reduce tendency to adhere. At ordinary operating temperatures, a lubricant film keeps surfaces apart and evolution of frictional heat at a low value. At an ambient temperature above that of decomposition of the oil, combination of high ambient temperature and frictional heat accentuates tendency to weld.

Coefficient of friction is proportional to average shear strength of the welds formed, and inversely proportional to the flow pressure of the softer of the mating materials. Lowest friction is achieved in a duplex type of structure which contains a hard load-bearing matrix coupled with a material which forms a weak bond with the other surface. The weak bond is achieved by using two chemically dissimilar mating surfaces which bond with low adhesive forces. Since some adhesion and transfer of material always occur even among the most dissimilar of materials, it is advantageous to choose as one component a material that is inherently weak. This material should also have a melting point not far above operating temperature of the seal, thus restricting surface temperature rise to a value governed by this low-melting component.

These principles govern all premium bearing materials used in high-speed, high-load applications today. All materials have a duplex structure of two phases, i.e., a hard one which bears the load, and a soft, thin, easily sheared layer which contacts the mating face. Structures may consist of hard particles embedded in a soft matrix as in the babbitts, soft particles in a hard matrix as in copper-lead, layers as in silver-plated and lead-indium coated bearings—or these phases may be evenly dispersed as in powder metallurgy compacts of silver-tungsten. In such duplex structures, the more critical of the two materials is the softer-surfaced one.

Recent seal material development work centered around compositions of a soft silver phase infiltrated into a porous nickel matrix containing 5 to 10 per cent of an extremely hard material such as chromium boride or tungsten carbide. Nickel-base specimens were prepared by powder-metal techniques and were rated against Graphitar specimens used as standards. Specimens were run against the face of a hardened and lapped tool-steel at surface speeds of approximately 18,000 fpm with a pressure of 11.5 psi against seal faces. Seal wear as a function of temperature is shown in Fig. 1.

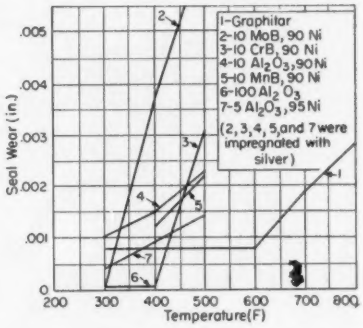
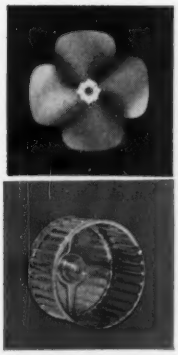


Fig. 1—Seal wear as a function of temperature

Good wear properties of graphite seal materials up to 600 F are due to self-lubricating properties. However, at temperatures of 1000 F, oxidation rates of these materials make them useless. There are new materials which can be used at temperatures over 1000 F without measurable deterioration. Also, new nickel-base materials form a beneficial oxide at high temperatures which reduces surface friction.

From "Development of Friction-Seal Materials for High-Temperature, High-Speed Operation," WADC Technical Report 56-579.



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Circle 493 on page 19

Helpful Literature
for Design Executives

For copies of any literature listed, circle Item Number on Yellow Card—page 19

Thyratrons & Rectifier Tubes

Charts, wiring, schematics, cross reference replacement data, and descriptive data on Cetron-Taylor line of thyratrons and rectifier tubes are content of catalog 557. 12 pages. Continental Electric Co. - Taylor Tubes, Inc.

Circle 671 on page 19

Switches

Switches for computers, high speed switching devices, and other industrial equipment are illustrated in folder W-2-7. Basic units for controlling and sensing motion and interlocking circuits, rotary selectors with maintained or momentary detents, pushbuttons, toggles, and door interlocks are shown. 4 pages. Minneapolis - Honeywell Regulator Co., Micro Switch Div.

Circle 672 on page 19

Aluminum Bibliography

All available Alcoa literature and motion pictures of interest to designers are discussed in "Bibliography of Information about Aluminum for the Designer." Ordering information is included. Aluminum Co. of America.

Circle 673 on page 19

Potentiometer

General information, dimensional diagram, and specifications for a 2-in. high resolution precision potentiometer are included in catalog sheet. 2 pages. DeJur-Amsco Corp.

Circle 674 on page 19

Self-Lubricating Bearings

Specifications and tolerances for Ledaloyl plain cylindrical, flanged, and spherical single hub and double hub self-aligning bearings are content of illustrated folder. Stock sizes are listed. 6 pages. Johnson Bronze Co.

Circle 675 on page 19

Hexagon Nuts

Specifications and prices of ¼ to 3-in. sizes of finished full, national high, heavy full, light full, and regular full slotted hexagon nuts of various types are content of catalog section. The 12-pointer nut, interchangeable with finished or light hexagon nuts in ¼ to ⅝-in. sizes, is also covered. 24 pages. National Machine Products Co.

Circle 676 on page 19

Valves, Driers, & Strainers

Valves, driers, strainers, and accessories for refrigeration, air conditioning, and industrial applications are subject of catalog 102. Each product is described in detail, illustrated, and its specifications are given. 16 pages. Henry Valve Co.

Circle 677 on page 19

Impervious Graphite

Recommendations for application of Karbate impervious graphite and National resin base cements in corrosive service are found in catalog section S-5050. Tables show grade of product to be used in various commercial applications. 4 pages. National Carbon Co.

Circle 678 on page 19

Pillow Blocks

Data on construction features, dimensions, load ratings, interchange, engineering, mounting, and maintenance are included in pillow block catalog. 10 pages. General Motors Corp., New Departure Div.

Circle 679 on page 19

Diodes

Subminiature glass diodes described on data sheet B-215 incorporate alloys of silicon and germanium. They combine high reverse resistance, high forward conductance, and fast transient response of the two materials. 2 pages. Clevite Corp., Clevite Transistor Products Div.

Circle 680 on page 19

Hubs & Bushings

Ten stock sizes of steel hubs, plus three made-to-order sizes that accommodate all sizes of unbreakable malleable split taper compression bushings are illustrated and described in catalog HB-101-A. They are used to mount propeller fans, impellers, gears, plate sprockets, pulleys, etc. 4 pages. Browning Mfg. Co.

Circle 681 on page 19

Reinforced Plastics

Four basic manufacturing processes by which glass fiber reinforced plastics are developed to meet existing or new product requirements are outlined in illustrated folder. Properties are given. 4 pages. Structural Fibers, Inc.

Circle 682 on page 19

Resistor Alloy

An improved Copel copper-nickel resistance alloy for use on "cold" resistor applications in electronic devices, instruments, and other apparatus is subject of illustrated catalog M-56C-N. Specifications and prices for 54 wire sizes and 31 ribbon sizes are given, along with properties. 8 pages. Hoskins Mfg. Co.

Circle 683 on page 19

Nylon Parts

Techniques and equipment used in Process N to produce short run nylon parts at low cost are described in bulletin. Quantities of relatively small parts run from 15,000 to 50,000 per run. 4 pages. Nylon Molded Products Corp.

Circle 684 on page 19

Gas Dehydration Systems

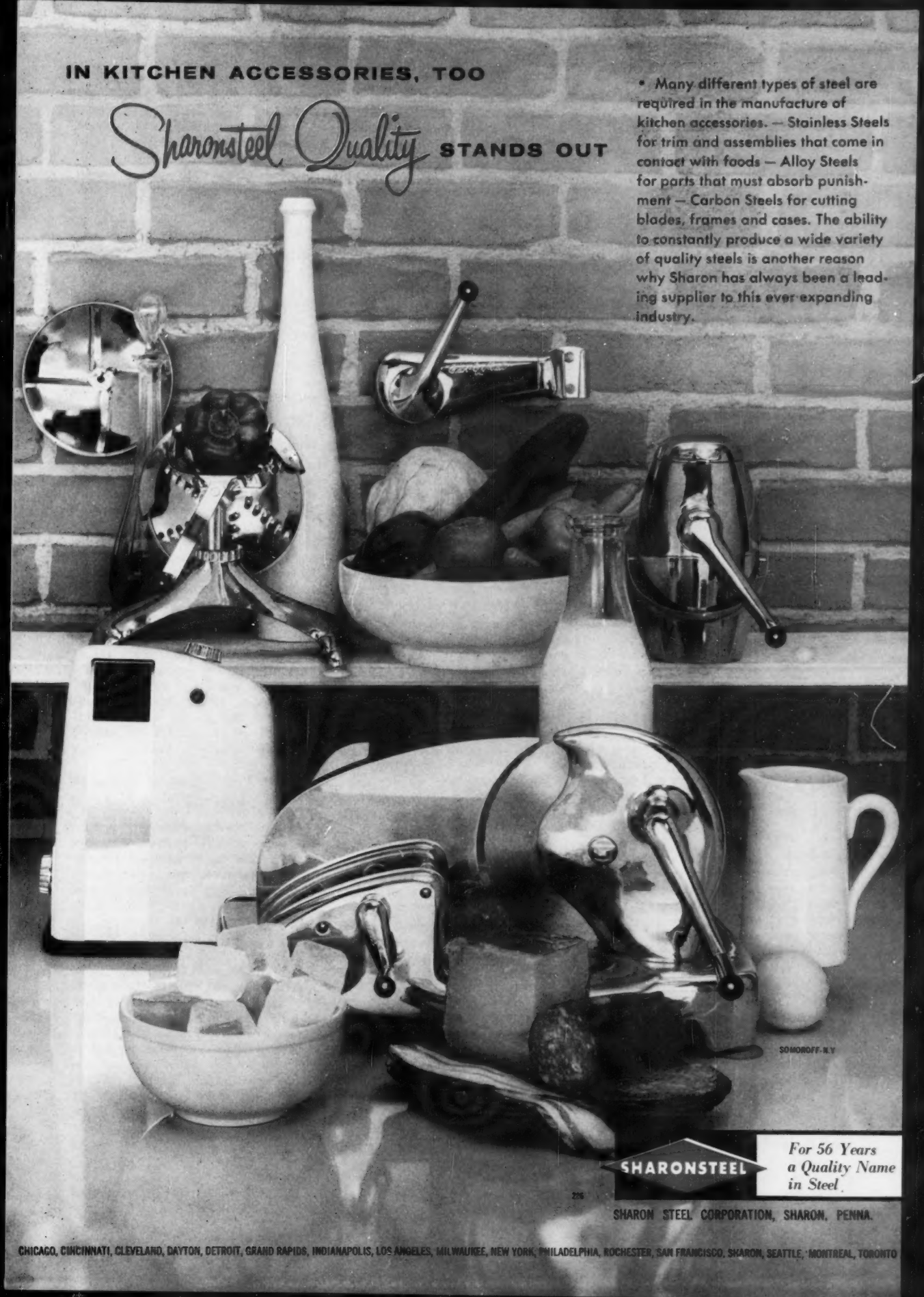
Outlines of six replaceable cartridge type dehydration systems for gases are found in illustrated bulletin 1157. General data, specifications, and ratings of mechanical filters, elements, purifier chambers, dessicant cartridges, oil vapor cartridges, reactivating dehydrators, and other components are included. 8 pages. Robbins Aviation.

Circle 685 on page 19

Seamless Tubing

"A Guide to the Choice of Seamless Mechanical Tubing" details how the product is produced and its uses; compares it with bar stock; and describes the differences between hot finished, cold drawn, and Roto-Rocked tubing. Available types and grades are covered. 8 pages. Bab-

Circle 494 on page 19→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cock & Wilcox Co., Tubular Products Div.

Circle 686 on page 19

Elapsed Time Meter

Ball bearing, 400-cycle, synchronous motor drives a digital counter through two worm meshes in the P/N 3101 elapsed time meter. The 115-v, 400-cycle ac unit is described and illustrated in bulletin A-104. It reads to 9999.9 hours. 2 pages. United Hydraulics, Inc.

Circle 687 on page 19

Epoxy Adhesives

Properties chart for Epibond adhesives and Epocast pastes includes such data as composition, weight, application, pot life, cure time and temperature, service temperature, shear strength, bond resistance, and typical applications. Furane Plastics Inc.

Circle 688 on page 19

Springs

"Perfection in Springs" is a booklet which shows examples of flat, extension, compression, heavy duty, torsion, and power springs; small stampings; wire forms; clips; and clamps made of various metals to specific requirements. 8 pages. Superb Spring Works, Inc.

Circle 689 on page 19

Large Nuts

Specifications, dimensions, and prices of large nuts milled from bar are found in catalog. Sizes range from 1½ to 4 in. Three types of heavy semifinished hex nuts and two types of finished hex nuts are covered. 4 pages. Acimet Mfg. Co.

Circle 690 on page 19

Wire Rope

Information on how to select and use wire rope to get the best service is found in Wire Rope Manual G-16. Strengths and related data on wire rope, slings, and cable assemblies are included. 190 pages. Macwhyte Co.

Circle 691 on page 19

Subminiature Connectors

Specifications, outline drawings, illustrations, and general information on subminiature connector series are contained in revised brochure SM 757. All are illustrated in actual size. 12 pages. DeJur-Amsco Corp.

Circle 692 on page 19

Shell-Molded Castings

Photostory of shell-mold casting procedure, and the quality control, design considerations, and materials used in it are contents of booklet DB-52-520. Typical shell-mold castings are shown. 8 pages. Westinghouse Electric Corp., Materials Mfg. Dept.

Circle 693 on page 19

Metal O-rings

Advantages of metal O-rings for fuel, hydraulic, compressed air, vapor, and gas lines; vacuum connections; and acids and other corrosives are presented in illustrated folder. They are usually made of type 321 stainless steel. Properties and available sizes are given. 4 pages. Advanced Products Co.

Circle 694 on page 19

Variable Speed Control

Variable speed control for operating direct current gearmotors from alternating current circuits is described in bulletin 25-2. It utilizes dry disk type selenium rectifiers and a variable voltage transformer. Reversing, nonreversing, jogging, and dynamic braking are offered. Janette Electric Mfg. Co.

Circle 695 on page 19

Aircraft Fasteners

Line of high strength aircraft fasteners for airframe and engine use is shown in form 2245. Included are tension and shear fasteners, self-locking nuts, preload-indicating washers, high temperature fasteners, and various other types of bolts and nuts. 4 pages. Standard Pressed Steel Co.

Circle 696 on page 19

Clutches

Self-energizing and manually or externally energized clutches of normally disengaged or engaged types are described in illustrated folder PSC-100. Design features, capacities, and typical installations are covered. 4 pages. Curtiss-Wright Corp., Marquette Div.

Circle 697 on page 19

Flexible Shafts

Various power transmission and remote control problems can be solved by line of standard flexible shafts described and illustrated in bulletin 5608. Specifications, torque loads, drive speeds, and other data are given for six models. 4 pages. S. S. White Industrial Div.

Circle 698 on page 19

Proportioning Pumps

McCannameter diaphragm pumps are capable of delivering up to 6 gph per feed at pressures up to 2500 psi and speeds to 900 strokes per minute. Pumps are designed for metering and proportioning a wide variety of fluids for practically any process requirement. Design and performance information is presented in illustrated bulletin 301. 4 pages. Hills-McCanna Co.

Circle 699 on page 19

Cartridge Heating Unit

Wide range of industrial applications is served by Firerod cartridge type heating unit, described in illustrated bulletin 365. Electric unit is made in ⅞ to 12-in. lengths in ⅜ and ½-in. diameters. Selection data, specifications, prices, and other data are included. 6 pages. Watlow Electric Mfg. Co.

Circle 700 on page 19

Manufacturing Facilities

File folder illustrates typical parts being produced for the aviation industry. Brief description of various materials used and machining operations required is included, along with pictures of various departments. Nine parts sheets are included. Moynahan Bronze Co.

Circle 701 on page 19

Roller Chain & Sprockets

Complete data on Diamond conveying and double-pitch power transmission chain are presented in illustrated catalog No. 37. Standard stock chain, sprockets, and attachments are shown, and charts are included to give all information needed for proper selection. Diamond Chain Co.

Circle 702 on page 19

Synthetic Rubber

"Hycar American Rubber" is title of technical guide to properties and applications of various special-purpose Hycar polymers. Easy-to-use tables list all pertinent data as well as suggested uses. 28 pages. B. F. Goodrich Chemical Co.

Circle 703 on page 19

Hinged Steel Belting

Semitechnical bulletin MF-600 describes complete line of hinged steel belting for conveying and mechanized handling of such problem materials as metal scrap, hot forgings, wet or dry chips, and abrasive materials. Plain, perforated, dimpled, multi-winged, and cleated steel belting are shown. 6 pages. May-Fran Engineering, Inc.

Circle 704 on page 19

Reproduction Materials

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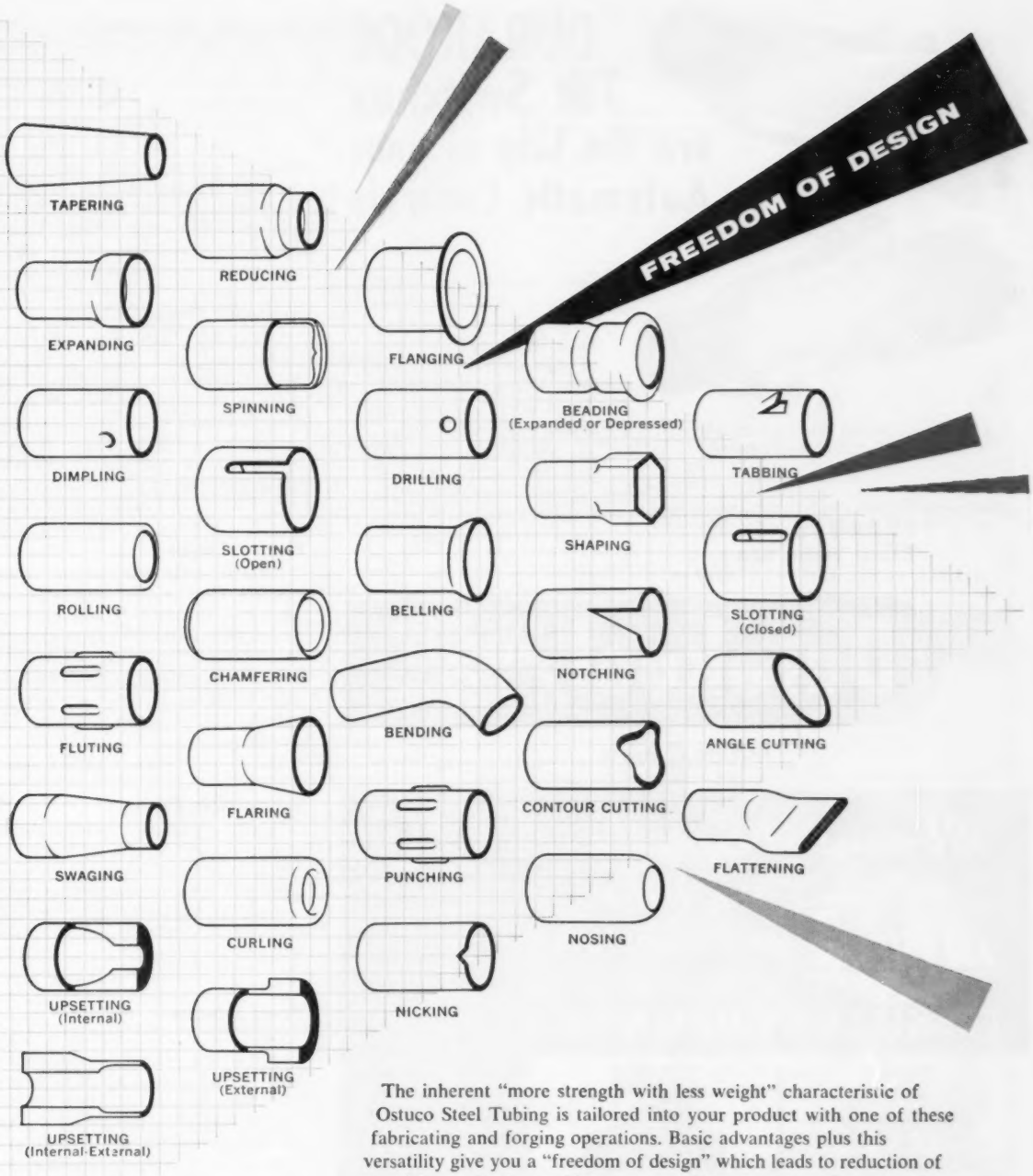

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Circle 496 on page 19

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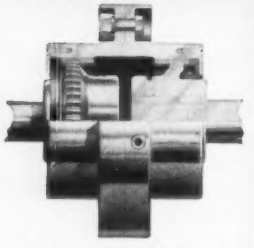

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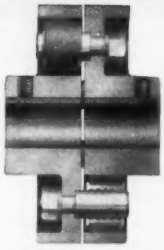

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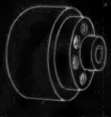

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Helpful Literature

exact duplicate originals from which needed prints can be obtained. Thus, valuable originals are protected from aging, wear, and loss. Illustrated bulletin explains how these intermediate whiteprint materials cut drafting time, speed design changes, and make complete prints. General Aniline & Film Corp., Ozalid Div.

Circle 705 on page 19

Hydraulic Power Units

Compact, portable, electrically driven, hydraulic power units which deliver sustained pressures to 3000 psi are detailed in bulletin 2-1022. Also described is air-hydraulic power unit which operates on air pressures up to 80 psi. 4 pages. Hi-Shear Rivet Tool Co.

Circle 706 on page 19

Electric Clutch

Offered with slip torque ratings ranging from 9 lb-ft and speeds to 4500 rpm to 540-lb-ft and 2500 rpm, model GS electric clutches are compact, reliable units for all types of power transmission control. Complete data on these clutches are given in bulletin 503. 4 pages. Stearns Electric Corp.

Circle 707 on page 19

Submersible Motors

"Facts About Submersible Motors" shows design features of these units which have been developed for use in deep well systems. Also detailed are various accessories for submersible installation. 12 pages. Franklin Electric Co.

Circle 708 on page 19

Pump Selector

Data sheet No. 345 is a handy pump selector chart for designers of heating and cooling systems. It gives capacities, heads and other information on pumps and circulators used in refrigeration, air conditioning, heating, and circulation applications. 2 pages. Barnes Mfg. Co.

Circle 709 on page 19

Seal Rings

Full information on the use of Quad Rings is given in illustrated reference book. These four-lipped seals are usable for reciprocating and rotary applications. Design considerations as well as engineering check lists are included. Minnesota Rubber & Gasket Co.

Circle 710 on page 19

Titanium Carbide Alloys

Heat-resistant titanium carbide alloys and their many applications are

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- ☐ "Guide for Routing and Installation of Aeroquip Flexible Hose Assemblies".

Name_____

Title_____

Company_____

City_____ Zone_____

State_____

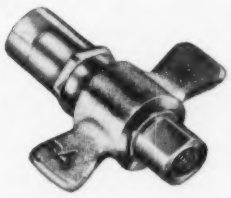
Specify These Aeroquip Flexible Hose Lines and Self-Sealing Couplings

FUEL, OIL, WATER, HYDRAULIC LINES—Single Wire Braid 1503 and 1502 Hose for medium pressure hydraulic, water, hot oil, crude and fuel oil, anti-freeze, gasoline, diesel fuel and air lines. In sizes from ¼" to 2½"; pressures up to 3000 psi.; temperatures from —40°F. to +250°F. Also available: 2651 Rubber Cover Hose.

HIGH PRESSURE LINES—Double Wire Braid 1509 Hose for high pressure hydraulic, grease, crude and fuel oil, gasoline and air lines. In sizes from ¼" to 2"; pressures up to 5000 psi., depending on size; temperature range —40°F. to +200°F.

LOW PRESSURE LINES—Aeroquip 2556 Hose and *SOCKETLESS* Fittings for low pressure oil, fuel and air lines on all applications. In sizes from ¼" to ¾"; for pressures up to 250 psi., temperature range —40°F. to +250°F. *SOCKETLESS* Fittings in male pipe, S.A.E., J.I.C. threads. (Patent applied for.)

HIGH TEMPERATURE LINES—2802 Hose (Teflon) and Reusable ***"super gem"*** Fittings for fluid systems subject to high temperature and corrosive fluids. Hose and fittings can be assembled with ordinary hand tools. In sizes from ¼" to 1"; for pressures up to 1500 psi.; temperature range —100° F. to +500° F.



SELF-SEALING COUPLINGS—Type 5100 (wing union nut) and Type 5110 (hex union nut) allow quick connection and disconnection of fuel, oil, hydraulic and air lines, replaces two shut-off valves. There is no loss of fluid or inclusion of air into the system on connection and disconnection of fully pressurized lines. In O.D. tube sizes from ⅛" to 1½"; for pressures up to 2000 psi.; temperature range —40° F. to +250° F.

SOCKETLESS and ***"super gem"*** are Aeroquip trademarks

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design with

compressors

to assure

Minimum

Maintenance

One of the strongest sales points you can design into your air-operated equipment is the dependability and efficiency of the air supply.

Ingersoll-Rand air compressors are engineered with proven features that will give longer trouble-free operation—*reducing* costly maintenance and excessive downtime.

Bare, baseplate or receiver mounted air compressors can be supplied to meet your specific requirements.

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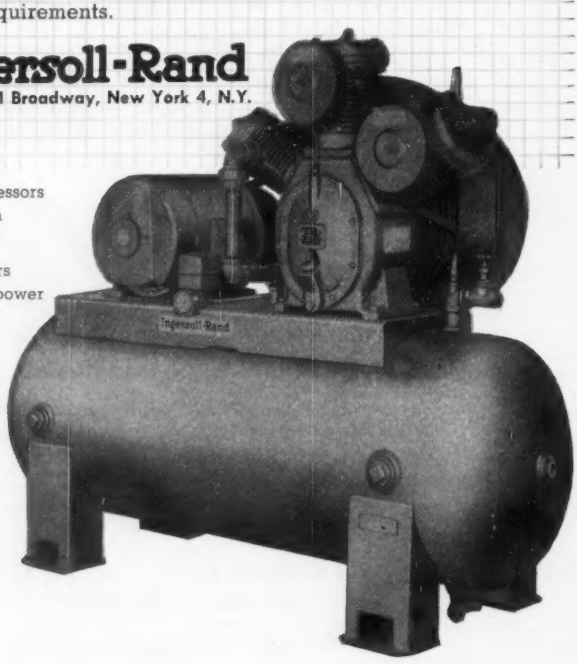


air-cooled compressors —½ through 20 horsepower

Other compressors to 6000 horsepower

3-675

Helpful Literature

subject of illustrated bulletin B-444. Parts of simple and complex shapes that have been used successfully at temperatures ranging above 1800° F are described. Physical properties of 13 different compositions are listed. 12 pages. Kennametal Inc.

Circle 711 on page 19

Hubs & Taper Bushings

The complete line of Browning steel hubs and malleable split taper bushings is described in catalog HB-101-A. These fittings provide a simple and economical means for mounting fans, impellers, gears, plate sprockets, conveyer pulleys, live rollers, conveyer rolls, washer drums, sheaves, couplings, clutches, and other items on shafts. 4 pages. Browning Mfg. Co.

Circle 712 on page 19

Hydraulic Accumulators

Piston type hydraulic accumulators in oil capacities from 10 cu in. to 10 gal are described in illustrated design data book 1530. Developed for service pressures up to 3000 psi, they function as auxiliary sources of hydraulic power. They are also used for shock absorption to keep the pressure constant and protect system components from excessive peak surges. 36 pages. Parker Appliance Co., Industrial Hydraulics Div.

Circle 713 on page 19

Preassembled Fasteners

Types of Sems lockwasher-screw fasteners available from this company are listed and detailed in illustrated bulletin 557C. Various lock washers are preassembled on practically any style screw or bolt. 4 pages. Pittsburgh Screw & Bolt Corp.

Circle 714 on page 19

Chemical Pumps

Complete data on Flex-i-liner sealless plastic and stainless steel pumps for handling all types of chemical and corrosive fluids are given in catalog 10.0. They have capacities of 0 to 40 gpm, with discharge pressures up to 60 psi, and will pump fluids at temperatures to 400° F. 8 pages. Vanton Pump & Equipment Corp.

Circle 715 on page 19

Centrifugal Castings

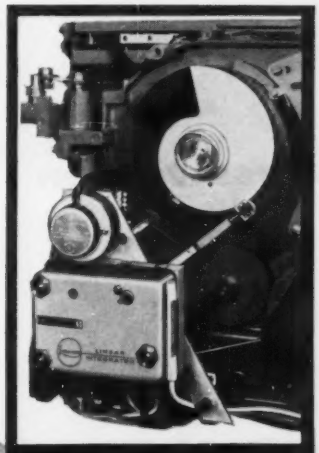
Examples of custom-made centrifugal castings in more than 70 alloys for specific service conditions are shown in catalog No. 200. They range in diameter from 7 to 54 in., with lengths as great as 33 ft, de-

THE LIBRASCOPE

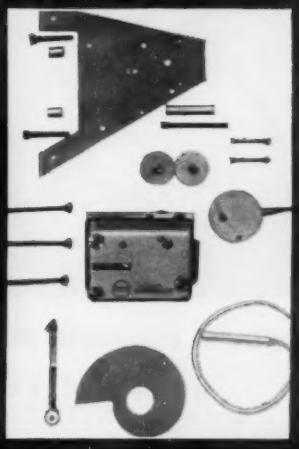
Model 25 COMPUTING LINEAR INTEGRATOR

for flow totalization · temperature recording averaging · area computations in gas analysis procedures

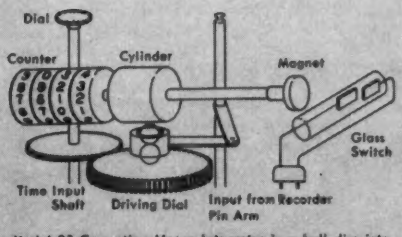
Eliminates manual integration of recording data.
Provides continuous integration.
Direct reading and also remote reading through electrical impulse output.
Fits all Standard or Miniature Strip Chart Recorders.



Model 25 Librascope Computing Linear Integrator mounted on a Strip Chart Recorder. In this position it accepts the output of the transducer or the recorder pen motion as an input.



Typical Adapter Kit of Model 25 Librascope Computing Linear Integrator with parts. These include baseplate, case, disc, roller, linkages, input shaft, bearings and carriage guides.



Model 25 Computing Linear Integrator is a ball disc integrating mechanism assembled with a counter and an electrical pulse output switch for remote recording.

The Model 25 *Librascope Computing Linear Integrator* is designed to provide a fast, accurate, reliable, continuously integrated total of data as it is being recorded or presented. (The Model 25 Computing Linear Integrator ends inaccuracies of totalizing by eliminating manual integration.) The Model 25 can be installed on any device having shaft rotation or displacements as an output.

SPECIFICATIONS

Shaft Rotation — 0° — 100°
Range — 0% — 100%
Input Shaft Torque — 0.1 in. oz.
Outputs —
Mechanical counter — 4 digits
Electrical Pulse
DC Volts: 28 — amps.: 0.5
AC Volts: 110 — amps.: 0.5
Size — 3.0" x 4.38"
Weight — 1.5 (lbs.)
Computer is sealed against dust.

Computors, Controls, Components

Representatives located in principal cities

LIBRASCOPE
A SUBSIDIARY OF CPE

Librascope, Incorporated • 808 Western Ave. • Glendale, California

Installation kits are designed to fit any standard or miniature chart recorders.
For detailed information of Model 25, write for Computing Linear Integrator Bulletin just released.

Circle 500 on page 19

A

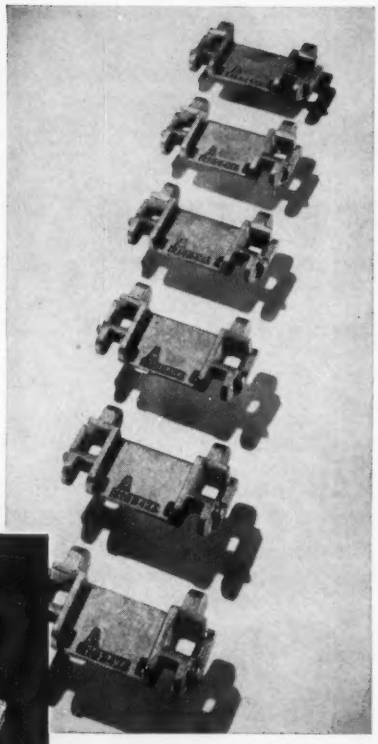
QUARTER MILLION

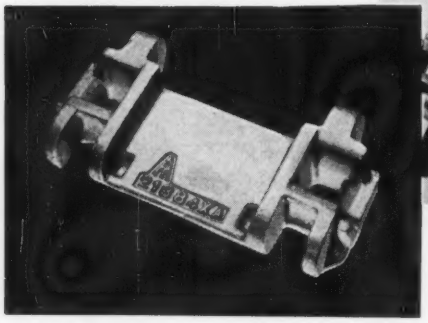
"STEPS"

IN THE

RIGHT

DIRECTION . .





Today's Modern Miner does BETTER with UNITCASTINGS!

Real proof of the continuous high quality of Unitcastings is the fact that more than 99 percent of the total production of 250,000 treads has been accepted!

Continual operation in underground grit and dust subjects mining machinery treads to extreme abuse. Replacement is difficult and expensive, particularly on this section of the equipment, and parts must be made to last!

For over a decade, the abrasion-resistance quality of Unitcast's T-Loy 34 has answered this tread problem—as well as many other special parts for the same equipment.

Take a step in the right direction, too—*you'll do better with Unitcastings!* They're Engineered!

UNITCAST CORPORATION • Toledo 9, Ohio

In Canada: CANADIAN-UNITCAST STEEL, LTD., Sherbrooke, Quebec

Unitcast

SPECIFICATION STEEL CASTINGS

Circle 501 on page 19

Helpful Literature

pending upon the diameter. Properties of the different alloys are tabulated. 12 pages. Sandusky Foundry & Machine Co.

Circle 716 on page 19

Aircraft Valves

Check valves, fluid relief valves, shut-off types, and shuttle valves for use in aircraft, missiles, and rockets are covered in bulletin 3S-2221. Designs for general, low pressure, and corrosive service are described. 4 pages. James, Pond & Clark, Inc.

Circle 717 on page 19

Stop Clock

Technical and application data on a new electric stop clock for industrial, laboratory, or military use is given in bulletin PB-691. This electrical reset time totalizer is offered in 60 minute and 60 second time ranges. 4 pages. Cramer Controls Corp.

Circle 718 on page 19

Electric Switches

Data sheets 129, 131, 132, and 134 contain full information on explosion-proof limit switches, adjustable mounting brackets for basic Micro Switches, new impact actuated switch, and pull-to-unlock toggle switches, respectively. Four 1-page bulletins. Minneapolis-Honeywell Regulator Co., Micro Switch Div.

Circle 719 on page 19

Traveling Wave Tubes

Technical bulletin No. 1 is entitled "Traveling Wave Tubes." These electronic amplifier devices are especially suited for handling frequencies in the microwave region. Operating principle and applications are discussed. 6 pages. Sperry Gyroscope Co., Electronic Tube Div.

Circle 720 on page 19

Pillow Blocks

Engineering drawings, tabulated dimensions, shaft sizes, weights, and radial load ratings are some of the design information presented in bulletin A-668 on Spher-Align spherical roller bearing pillow blocks. Sizes are available to accommodate shaft diameters up to 8 in. 8 pages. Dodge Mfg. Corp.

Circle 721 on page 19

Plastic Pipe & Fittings

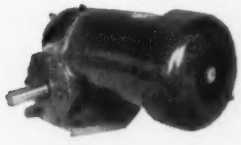
"Triangle Rigid High Impact Plastic Pipe and Fittings" are described as to applications, chemical resistance, electrical properties, physical properties, working pressures, and pressure drop in technical catalog

Now... Century announces a completely new line of fractional-HP right angle shaft type GEARMOTORS

New, "Smaller and Better" 48 and 56 Frame Century Motors

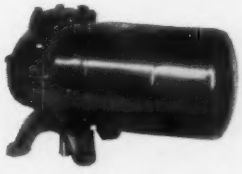
Weight reductions up to 1/3
Gearmotors operate in any position
Compact design saves space
Tapered roller bearings on low speed shaft
Finest rotary face-type oil seal on high speed shaft
Wide variety of mounting and motor types

Single reduction AGMA output speeds from 25 to 280 RPM (Double reduction as low as 4 RPM)



For floor mounting, complete with new type 56-Frame totally-enclosed, fan-cooled motor. External fan fully protected by cover. Substantial mounting on gear housing supports overhung loads on shaft. Type SC three phase motor shown. Ratings up to ¾ HP.

New IR 40 with 48-Frame motor. Gear housing shown is in one of eight possible positions. Open type single phase capacitor-start Type CS motor. Strong welded foot assembly and heavy motor frame assure smooth operation with severe sprocket loading. Ratings up to ½ HP.



Typical special purpose mounting to suit driven machine. Output shaft is vertical downward extension, properly sealed against oil leakage. Capacitor-start type motor has special smooth cover over capacitor and terminal connections to facilitate cleaning to meet sanitary requirements. Ratings up to ¾ HP.

Basic horizontal unit as assembled with 56-Frame open type motor. Motor is Type SC polyphase. Multi-speed, crane and hoist duty and other special types available. Note convenient vent and filling plugs on gear housing. Ratings up to ¾ HP.

Call your nearby Century District Sales Office or Authorized Distributor

. . . Your best motor investment is Century

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Performance-Rated© MOTORS
1/20 to 400 HP

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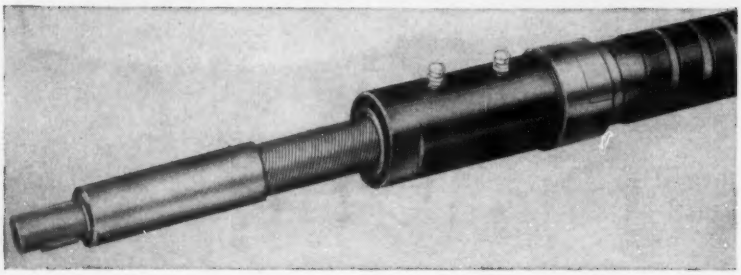
HOW TO SELECT FLEXIBLE SHAFTING FOR POWER DRIVE APPLICATIONS



1¼-inch STOW Power Drive flexible shaft with core assembly pulled out of casing.

For Power Drive applications, the following factors must be considered:

1. Torque (Lb. In.) to be transmitted. (The starting torque should be used in making selections.)

2. Operating Speeds (RPM) — If the maximum speed is higher than the rated speed, torque ratings in the table below do not apply. To find the torque capacity for flexible shafts operating at speeds higher than the rated speeds, multiply the maximum dynamic torque capacity by the rated speed, and then divide by the operating speed. (See example.)

3. Operating Radius—In making the selection from the table below, the radius of the smallest bend in the flexible shaft should be used.

Ratings — The ratings for flexible shafts shown in the table below apply under the following conditions:

1. When the flexible shaft is adequately supported by clamps along its length. (For unsupported shafts, multiply the calculated torque by a safety factor of 1.6—see example below.)

2. When the flexible shaft is operated in the wind-up direction, which tends to tighten the outer layer of wires. (Flexible shafts operated in the unwind direction will transmit only about 60% of the rated torque.)

3. When the flexible shaft is in continuous operation. Note: **the ratings are based on temperature rise. When the operation is intermittent, the ratings in the table may be exceeded. Consult Stow engineers for specific recommendations.**

RATED SPEED R.P.M.	MAXIMUM DYNAMIC TORQUE CAPACITY (LB. IN.) STRAIGHT AND CURVED SHAFTS RADIUS OF CURVATURE IN INCHES									Wgt./ C. Ft.	Core Dia.	Core No. and Type	Shaft Size
	50 to Strgt.	25	20	15	12	10	8	6	5				
4,500	2.4	2.2	2.0	2.0	1.92	1.9	1.7	1.5	1.25	3.0	.124/.128	2049 MH	13
3,800	7.0	6.4	6.0	5.8	5.4	5.0	4.6	3.6	2.0	4.5	.148/.152	2081 MH	15
2,900	9.4	8.6	8.0	7.6	7.0	6.6	6.0	4.8	3.4	7.0	.185/.189	5108 MH	19
2,300	22.0	20.0	18.8	17.6	16.0	15.0	12.6	10.8	9.0	12.5	.247/.252	8924 MH	25
1,800	30.0	28.0	26.4	25.0	23.0	21.0	18.0	14.0		20.0	.308/.313	8925 MH	31
1,800	33.8	31.5	29.7	28.1	25.9	23.6	20.2	15.8		20.0	.308/.313	8969 T	31
1,800	36.0	33.0	31.6	30.0	28.0	26.0	22.0	18.0	11.0	21.0	.324/.329	2034 A	31
1,500	80.0	66.0	63.0	58.0	51.0	46.0	37.0	22.0		28.5	.368/.374	2035 A	38
1,500	60.0	54.0	50.0	46.0	42.0	38.0	30.0	24.0		29.0	.387/.393	8970 MH	40
1,500	90.0	81.0	75.0	69.0	63.0	57.0	45.0	36.0		29.0	.387/.393	8971 T	40
1,150	136.0	110.0	104.0	94.0	80.0	72.0	56.0			50.5	.497/.503	8999 A	50
1,150	148	124	110	92	72	56				53.5	.505/.511	6940 T	50
900	248	200	176	124	84					78.5	.610/.618	6997 T	63
900	220	204	192	180	152	130				80.5	.630/.638	7731 A	63
750	340	224	156	76						117	.747/.753	2056 T	75
600	760	520	420							205	.998/1.004	2057 T	100
440	1,500	720								343	1.298/1.304	2058 T	125

EXAMPLE — How to use the table:

The problem is to transmit ½ H P at 1700 RPM through an unsupported flexible shaft in a 25″ radius, estimated starting torque 150% of normal operating torque.

1. Calc. Torque (lb. in.)— $\frac{HP \times 63000}{RPM} = \frac{.5 \times 63000}{1700} = 18.5$
2. Correction factor for starting torque 1.5 x 18.5 = 27.75
3. Correction factor for unsupported shaft 27.75 x 1.6 = 44.4 lb. in.
4. Refer to Table No. 1. Read downward in column under 25″ radius until you find a core having a rating of at least 44.4 lb. in. In this case we find that core No. 8970 is rated 54 lb. in. at 1500 RPM. Since the given speed is 1700 RPM, multiply 54 by 1500 and divide by 1700. 54 × 1500 ÷ 1700 = 47.6 lb. in. (rated torque at 1700 RPM). Therefore, Core No. 8970 is correct.

STOW

For Engineering Bulletin No. 570 and a free torque calculator, write

STOW MANUFACTURING COMPANY

11 Shear Street • Binghamton, New York

Helpful Literature

of this title. A fittings section is included. 16 pages. Triangle Conduit & Cable Co., Plastic Pipe Div.

Circle 722 on page 19

Conducting Wire Rope

Copper wire conductors imbedded in fiber center and "laid-up" in regular steel wire rope comprise Acco Signalkore wire rope. Functioning as wire rope, it also transmits electrical energy for communication. Bulletin DH-91 covers this product. 4 pages. American Chain & Cable Co., Wire Rope Div.

Circle 723 on page 19

Protective Coatings

Advantages of halofluorocarbon dispersion coatings for industrial corrosion control are pointed up in booklet H-JFCS. Metals that withstand 475-515° F can be coated with these Kel-F dispersions. Applications are illustrated. 4 pages. Minnesota Mining & Mfg. Co.

Circle 724 on page 19

Self-Locking Bolts

Nylok self-locking bolts with the nylon locking insert can be used for problem fastening jobs involving adjustment, liquid sealing, and vibration. Folder 792 outlines characteristics of nylon and suggests applications for these bolts. 4 pages. Republic Steel Corp., Bolt & Chain Div.

Circle 725 on page 19

Mercury Relays

Engineers' Fact File on mercury plunger relays and related items provides load ratings and contact data, coil characteristics, mounting dimensions, diagrams, and general information. Units for loads up to 20, 35, and 60 amp, or 5 hp at 115 v ac are covered. Ebert Electronics Corp.

Circle 726 on page 19

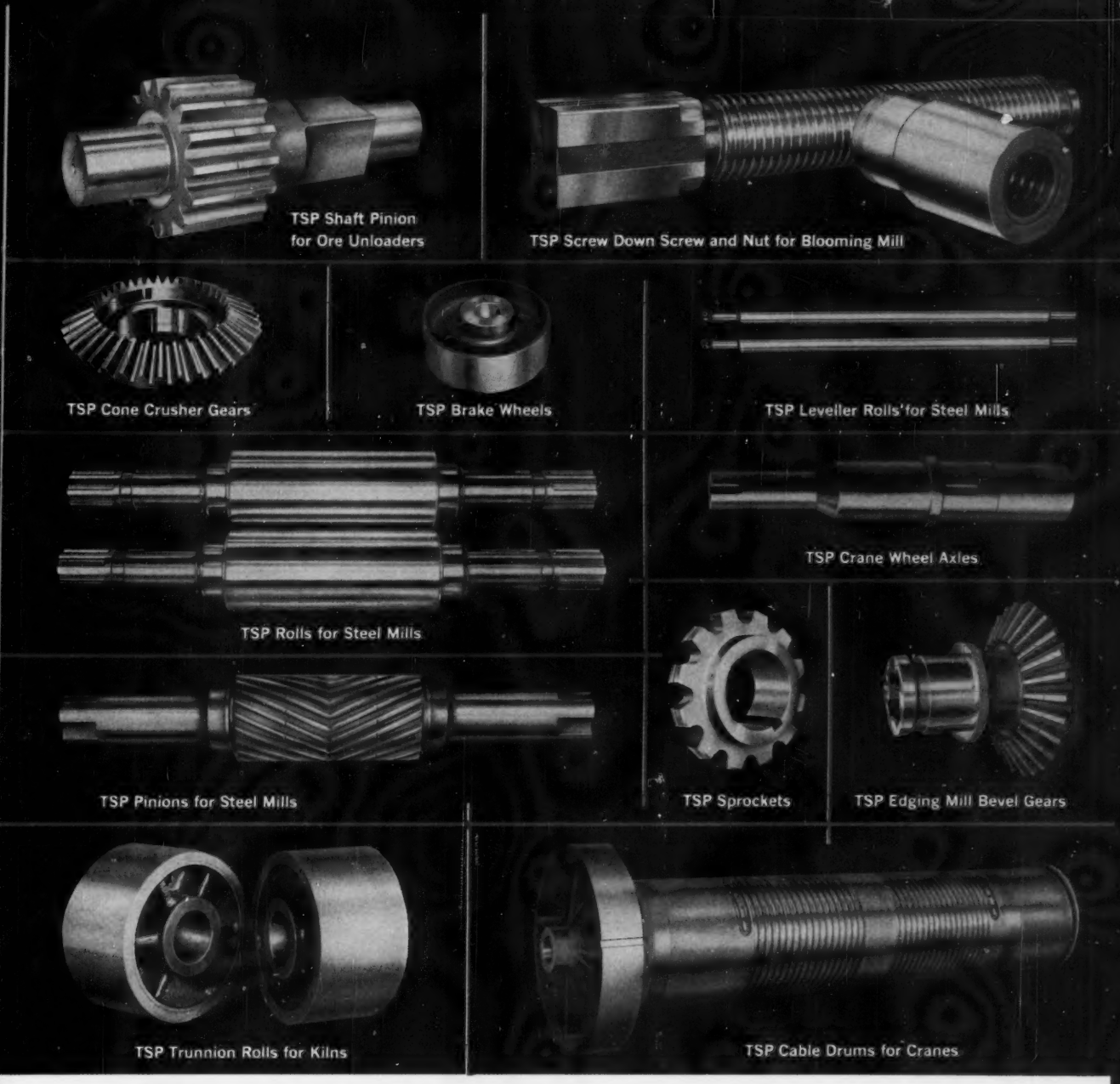
Hydraulic Component Tester

HA series hydraulic accessories test machine is designed for functional and operational testing of aircraft and industrial hydraulic components. It handles variable flows up to 20 gpm and pressures to 5000 psi. Brochure HA-100 describes this machine and its optional equipment. 4 pages. Greer Hydraulics, Inc., Test Equipment Div.

Circle 727 on page 19

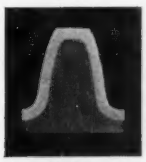
Tube Fabricating Facilities

Facilities for producing copper and brass tubing as well as drawn aluminum tubing and extruded aluminum shapes are shown in booklet 5805. Products are used for refrigeration


TSP Shaft Pinion for Ore Unloaders
TSP Screw Down Screw and Nut for Blooming Mill
TSP Cone Crusher Gears
TSP Brake Wheels
TSP Leveller Rolls for Steel Mills
TSP Crane Wheel Axles
TSP Rolls for Steel Mills
TSP Pinions for Steel Mills
TSP Sprockets
TSP Edging Mill Bevel Gears
TSP Trunnion Rolls for Kilns
TSP Cable Drums for Cranes

TSP parts give your product a big competitive advantage

Wherever you use a "Tool Steel Process" hardened part as a component, replacement problems are virtually eliminated. They are guaranteed in writing to outlast, out-perform any competitive part in the same service. TSP hardened parts increase the efficiency and quality of your product, resulting in greater customer acceptance. Their phenomenally long wearing qualities are a result of our special hardening process. The file hard surface to the full depth of permissible wear gives maximum life. The core, refined for toughness and ductility, gives maximum strength. Note depth of hardness on gear tooth cross section.



TSP hardened parts, a few of which are illustrated, are made to order from your blueprints, or to fit existing equipment. Gears made in sizes to 90" diameter. Other products up to 20,000 lbs. weight. Write for Bulletin 352 "Why Are They Called TSP Products", and complete information about TSP applications for your product.

THE TOOL STEEL GEAR AND PINION CO.
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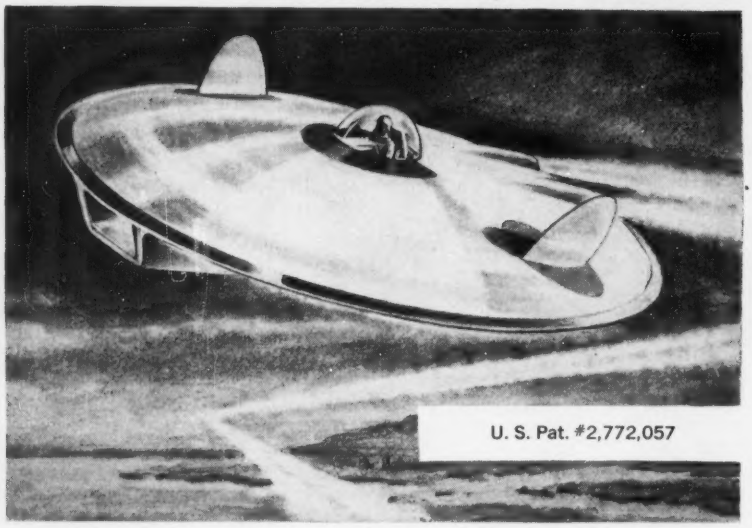
The Standard of Quality Since 1909 for Gears • Pinions • Rolls • Wheels and Other Hardened Products

Circle 504 on page 19

MARS outstanding design **SERIES**



saucer secret?

Whose incredible design is the flying saucer?

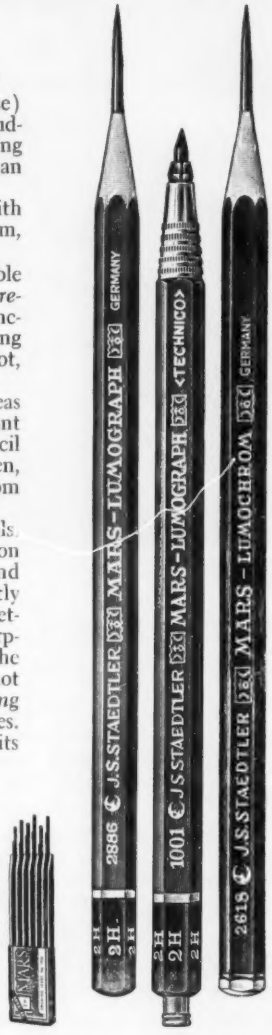
These flying objects (unidentified, of course) maneuver at high speed, with human-crushing suddenness. Their unearthly behavior poses a perplexing problem to imaginative designers: how might man survive in them?

John C. Fischer, Jr. approached the problem with this circular aircraft and its unique control system, U. S. Pat. #2,772,057.

This "saucer's secret" is a rotatably adjustable shell (upper) and a pilot's compartment which *pre-rotates* toward the direction to be flown. The functional design "humanizes" saucers because the rotating provisions distribute *g-forces* laterally on the pilot, minimizing blackouts.

No one can be sure which of today's new ideas will become reality tomorrow. But it will be important then, as it is now, to use the best of tools when pencil and paper translate an idea into a project. And then, as now, there will be no finer tool than Mars – from sketch to working drawing.

Mars has long been the standard of professionals. To the famous line of Mars-Technico push-button holders and leads, Mars-Lumograph pencils, and Tradition-Aquarell painting pencils, have recently been added these new products: the Mars Pocket-Technico for field use; the efficient Mars lead sharpener and "Draftsman's" Pencil Sharpener with the adjustable point-length feature; and – last but not least – the Mars-Lumochrom, the new colored *drafting* pencil which offers revolutionary drafting advantages. The fact that it blueprints perfectly is just one of its many important features.



The 2886 Mars-Lumograph drawing pencil, 19 degrees, EXEXB to 9H. The 1001 Mars-Technico push-button lead holder. 1904 Mars-Lumograph imported leads, 18 degrees, EXB to 9H. Mars-Lumochrom colored *drafting* pencil, 24 colors.

J.S. STAEDTLER, INC.
HACKENSACK, NEW JERSEY

at all good engineering and drawing material suppliers

Helpful Literature

and include seamless and heat exchanger tubing. Typical products are shown. 12 pages. Calumet & Hecla, Inc., Wolverine Tube Div.

Circle 728 on page 19

Stainless Steel Hinges

More than 30 sizes of continuous or piano type stainless steel hinges, as well as butt, fixed pin, and loose pin types are listed with specifications in data sheet. 1 page. Star Stainless Screw Co.

Circle 729 on page 19

Engineering Data

Among the "Useful Engineering Data" included in folder of this title are viscosity values for crankcase oils and transmission and axle lubricants, inch-millimeter conversions, temperature conversions, and a relation graph on shaft diameter fpm and rpm. 4 pages. Chicago Rawhide Mfg. Co.

Circle 730 on page 19

Fast Machining Steels

Selection guide 99-1 describes more than 20 different types of carbon, alloy and stainless steels designed for maximum output of machined parts. Featured are the new fast-machining leaded steels. Both free cutting bar and plate steels are included. 4 pages. Joseph T. Ryerson & Son, Inc.

Circle 731 on page 19

Variable Voltage Adjustors

Variable voltage adjustors are regulating transformers designed to step-up or step-down voltages to a normal required for maximum performance of electric powered equipment. Primary ranges of 65 to 145 and 145 to 240 v are covered by two series, described in catalog VA 312. 4 pages. Acme Electric Corp.

Circle 732 on page 19

Automatic Welding Supplies

Weldirectory SB-1354 lists automatic electrodes and fluxes for submerged arc welding and hardsurfacing. Typical properties of weld deposits and a guide for flux selection are highlights. Automatic welding of alloy steels is discussed. 8 pages. Lincoln Electric Co.

Circle 733 on page 19

Multiheaders & Plugs

Catalog No. 657A condenses information on over 10,000 different types of hermetic seals relative to Vac-tite compression multiheaders and plugs. Parts are grouped to provide essential information, part numbers are simplified and dimensions standardized

Circle 505 on page 19

Amweld® Hits Your Cost Target

Forming and flash butt-welding of mill-rolled or extruded shapes has cut the cost of rings and other circular parts by as much as 50%! Savings to one manufacturer in reduced machining time and material was $220.63 per ring. Where expensive metals such as titanium and heat-resistant alloys are used, flash butt-welding offers the most economical and practical method of manufacturing circular products.

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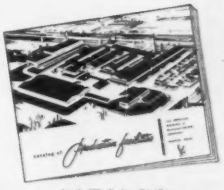

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Circle 507 on page 19

Helpful Literature

for easy reference. 16 pages. Hermetic Seal Corp.

Circle 734 on page 19

Variable Autotransformers

New additions to line of Variac variable autotransformers are described in form 424-OA, a supplement to bulletin O. Essential dimensions, specifications, and ratings for these units and for typical ganged Variac assemblies are provided. 4 pages. General Radio Co.

Circle 735 on page 19

Projection Weld Nuts

Advantages in simplification of design of manufactured products through use of M-F projection pilot and recessed type weld nuts are outlined in brochure. Sizes, dimensions, and specifications are included. 4 pages. MacLean-Fogg Lock Nut Co.

Circle 736 on page 19

Multicontact Relays

Latest in a series of engineering bulletins deals with specific applications involving soils and contact arrangement of type 4 multicontact relays. Four basic groups in actual size drawings are shown. Data cover both enclosed and hermetically sealed units. Phillips Control Corp.

Circle 737 on page 19

Flow Regulators

Illustrated brochure presents company's new flow regulators for airborne equipment. How they are used in aircraft, or in any product where control of flow is necessary is shown. 8 pages. Waterman Engineering Co.

Circle 738 on page 19

Forming Metal

Basic principles of expanding, shrinking, and roll forming of metal by the Grotnes method are described in illustrated booklet 555. No machining, heat, or destruction of the metal occurs. Machines for making various parts are shown. 8 pages. Request on company letterhead from Grotnes Machine Works, Inc., 5454 N. Wolcott Ave., Chicago 40, Ill.

Solenoid Valves

Eight indexed sections of Asco solenoid valve catalog 25 contain engineering data, illustrations, flow nomographs, and other information on two, three, and four-way solenoid valves; manual reset two and three-way valves; corrosion resistant valves; and special valves. 114 pages. Request on company letterhead from Automatic Switch Co., Florham Park, N. J.

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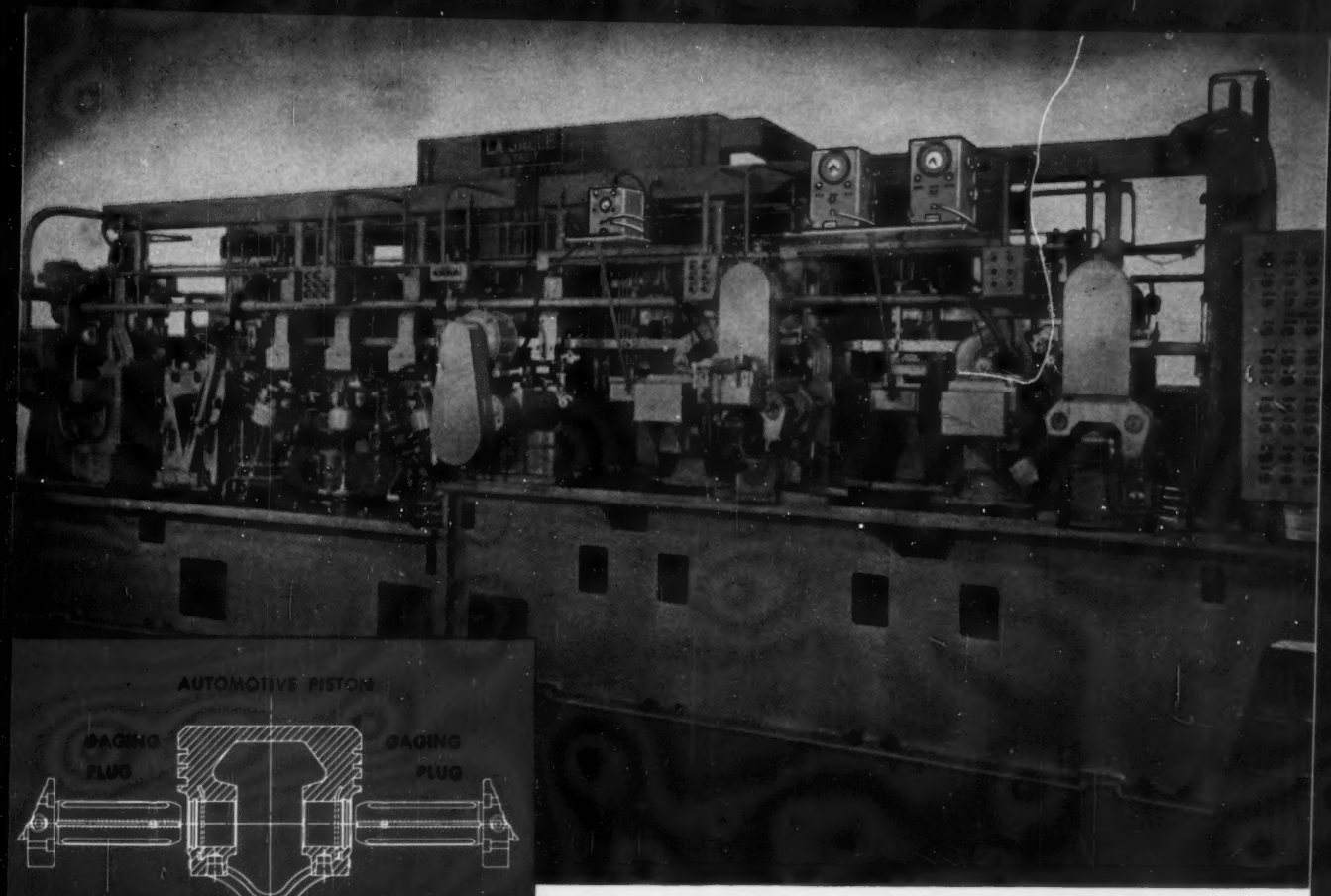
4-LIMIT UNIT . . . similar to 3-Limit Unit, but provides greater control scope. Indicates or controls such conditions as: "Approach High Limit," "High Limit," "Approach Low Limit" and "Low Limit."

Circle 508 on page 19



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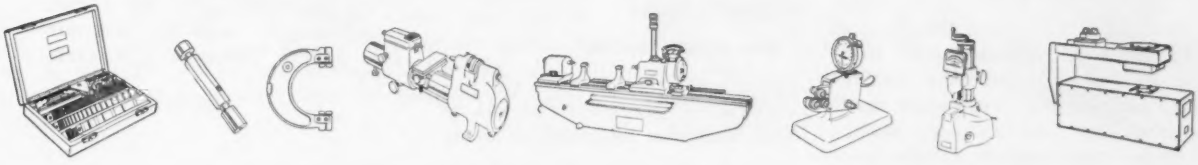
The EASY way to HIGH-PERFORMANCE DESIGN

PRATT & WHITNEY STANDARD, ON-THE-SHELF GAGE CONTROL UNITS

INCREASED OUTPUT RATES, INSURED ACCURACY, REDUCED REJECT RATES . . . these are the plus-performance factors that On-Machine or Automation Gaging can bring to a wide variety of production machines. And now, these standard P&W Packaged Units . . . with appropriate tooling . . . make it possible to provide an installation exactly tailored to your needs and easy to integrate into your present designs *without* the expense or delays required to engineer or construct special controls.

For example, these P&W Packaged Units made it easy to provide automatic on-machine gaging for this special, high-speed automotive piston machine produced by LaSalle Tool, Inc. Two P&W Air-O-Limit Carbide Gage Plugs are arranged to check the ID of both wrist pin bores on the pistons automatically. Lights on the P&W Control Units signal the operator if tolerances are exceeded. A second set of gage plugs similarly checks bores for the presence of snap ring grooves. If desired, control units can be arranged to shut down the machine automatically when an imperfect part is detected. Whatever *your* requirements, P&W can supply gaging equipment exactly right for the job.

For complete information, write to Pratt & Whitney Company, Inc., 33 Charter Oak Boulevard, West Hartford, Connecticut.



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Circle 508 on page 19

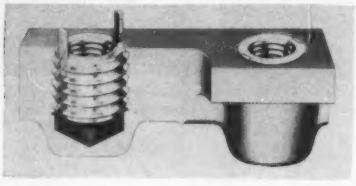
New Parts and Materials

Use Yellow Card, page 19, to obtain more information

Self-Locking Insert

is one-piece, all-metal unit

Easily installed self - locking threaded insert, designated Keensert, provides a strong internal thread for bolt attachment in relatively soft materials, such as aluminum and magnesium alloys and plastics. It can be installed in harder metals to provide a self-



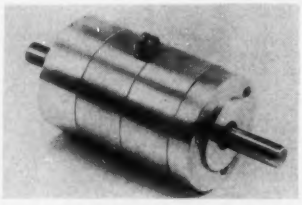
locking internal thread in a blind hole. A one-piece, all metal unit, insert is externally threaded along its entire length to provide maximum pull-out resistance. Prevailing torque is consistent and within range established in MIL-N-25027 (ASG), Table III. **Newton Insert Co.**, 6500 Avalon Blvd., Los Angeles 3, Calif.

Circle 739 on page 19

Clutches and Brakes

have high amplification ratio

Mechanical high-speed clutches and brakes have applications in automatic control, computing machinery and servo systems where small forces are available to control torque transmission. Units have high amplification ratio, built-in controls, coaxial input-output, and cylindrical envelope with provision for servo and flange mounting. Clutch mechanism is built into an envelope with diameter of 1 in. and length of 1⅝ in. Power pack is available to convert electrical



pulses to a triggering force. Units have minimum inertia, eliminating severe shock loads in starting and stopping. **Digitronics Corp.**, Albertson Ave., Albertson, L. I., N. Y.

Circle 740 on page 19

Composite Metal Strip

is silver-clad-on-copper for miniaturized components

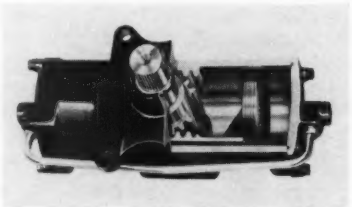
Designed for high - temperature and high-frequency applications of miniaturized components, silver-clad-on-copper is available in all thicknesses down to foil gages, to thickness tolerances as close as ±0.0001 in. Properties include oxidation resistance at high temperatures, excellent resistance to atmospheric corrosion, and exceptional electrical conductivity. **American Silver Co. Inc.**, 36-07 Prince St., Flushing 54, N. Y.

Circle 741 on page 19

Power Cylinder

has rotary motion

Operating from 600-1000 psi, rotary-motion power cylinder can be used wherever hydraulic or pneumatic pressure is available. It delivers 26,000 lb-in. torque output. Parameters can easily be varied to obtain custom installations. Overrunning clutches, gears and sprockets are easily adapted to output shaft to increase versatility. **Thompson Products Inc.**, Michigan Div., 34201 Van Dyke Ave., Warren, Mich.

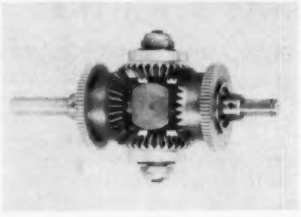


Circle 742 on page 19

Differential Gear Train

miniature unit has interchangeable end gears

Miniature differential is available in ⅛, 3/16, and ¼-in. diam shaft sizes. Interchangeable end gears run concentric to shaft within 0.0001-in. Static friction is 4 per cent or less, and backlash between



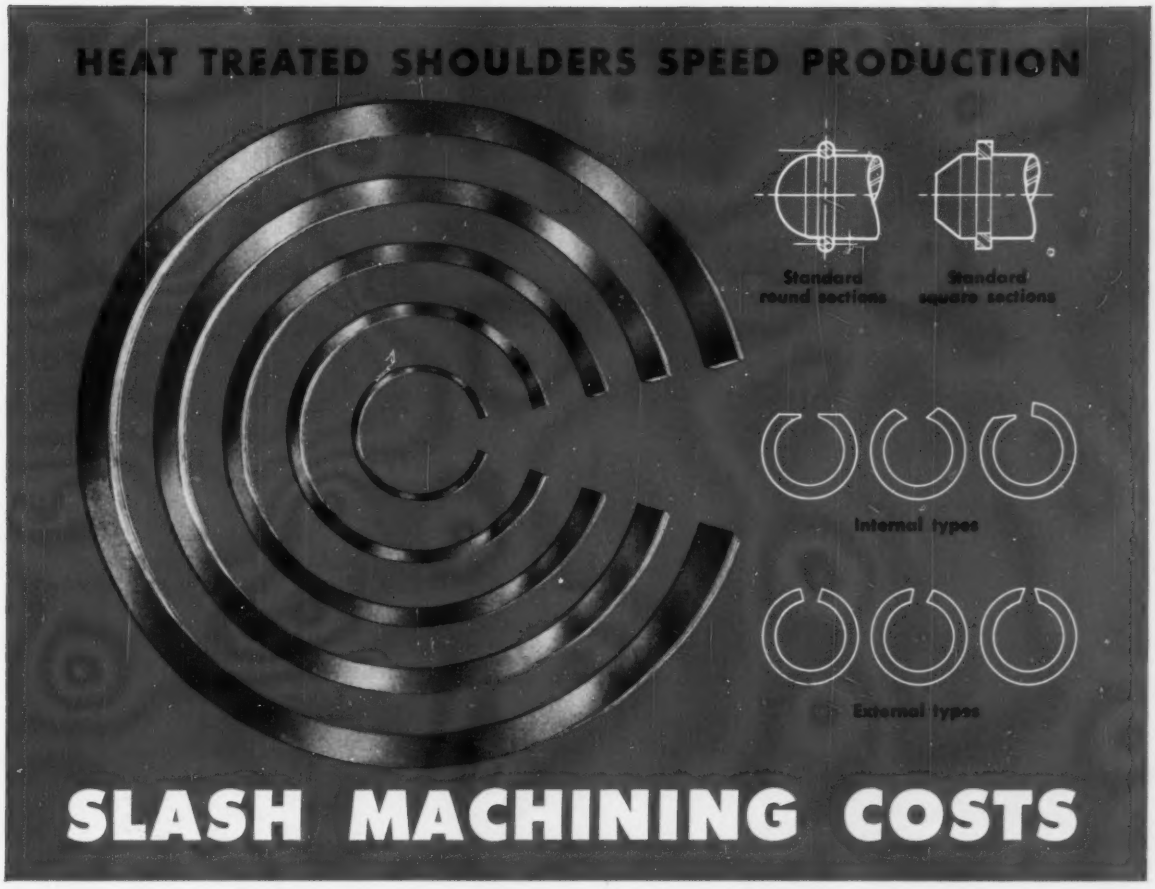
any two gears is 7 min of arc or iess. Design utilizes anodized-aluminum spider gears; other components are stainless steel. Unit meets applicable MIL and AGMA specifications. **Lyndon Aircraft Inc.**, 140-55 Clifford St., Newark, N. J.

Circle 743 on page 19

Cable Wrapping

is easily used, spiral-cut plastic

Spirap electrical cable wrapping can be applied to wire bundles with diameters to 3½ in. The spirally-cut polyethylene wrapping permits



EATON-RELIANCE Snap Rings

Machining costs CAN be reduced without reducing product quality. This is specifically true where Eaton-Reliance Snap Rings are used instead of machined shoulders on shafts and in counterbores. Design and industrial engineers save production man hours as well as valuable material. How? Eaton-Reliance Snap Rings allow shafts to be ordered to size rather than oversize. The metal taken from the small groove required for the snap ring is negligible compared to the amount wasted machining an entire shaft. The time it takes to machine a groove is only a fraction of that needed to fully machine a shaft either externally or internally.

These time and material savings add up to dollars.

Eaton-Reliance Snap Rings are being used successfully in industry throughout the country. They are designed for long life, made of steel cold drawn in our own plant, quality controlled from start to finish. You can rely on Reliance Snap Rings.

Send for your free copy of Engineering Bulletin No. 55 or write for the name of the nearest Eaton-Reliance representative.

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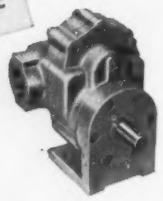
Circle 509 on page 19

ADEL *Industrial Hydraulic Equipment*

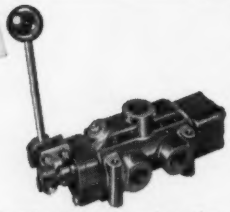
for PEAK PERFORMANCE ADEL Hydraulic Valves and Pumps are setting new and ever higher standards for precision in manufacturing and efficient performance in operation. Following are but a few of the wide variety of models to meet all operating conditions.

GEAR-TYPE HYDRAULIC PUMPS



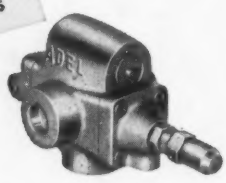
For 1000 psi service with rated capacities at 1800 rpm of from 1.5 to 46.8 gpm.

DIRECTIONAL CONTROL VALVES



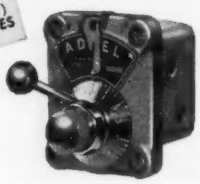
4-way valves with spring-centered, spring-offset, and 1, 2, or 3 position detent action. 1500 psi. Flows to 28 gpm.

BY-PASS VALVES



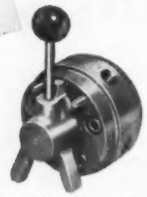
Relief, Sequence and Unloading valves. Direct or remote operation, 50 to 1500 psi range.

VOLUME (FLOW) CONTROL VALVES



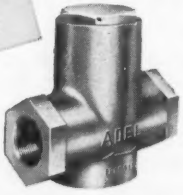
Compensated type maintains constant flow over wide differential pressure range. No drain line required. 1500 psi.

PILOT VALVES



2 or 3 position detent. With or without dog or lever. Can be used as 4-way valve in small circuits. 1000 psi.

CHECK VALVES



Valves allow free flow in one direction only. Many variations available. 3000 psi.

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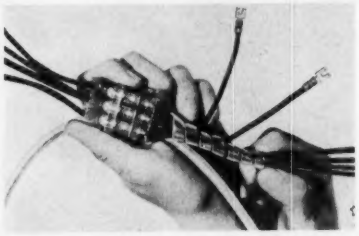
Circle 510 on page 19

New Parts

individual wires to be entered or led out at any point. It can be unwound to allow wires to be added, removed or relocated. Wrapping holds wires together tightly but permits flexibility for forming cable. Full protection for wires is



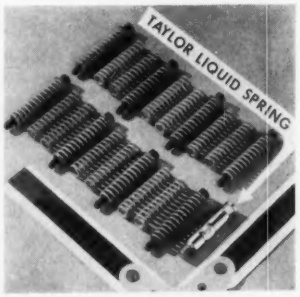
provided, and cable clamps can be used without damaging insulation. A fire-retardant type, designated Amp-Rap, is also available in the same size range. **AMP Inc.,** 2100 Paxton St., Harrisburg, Pa.

Circle 744 on page 19

Miniature Liquid Spring

develops 800-lb force at ¼-in. stroke

Model 416 liquid spring using liquid compressibility is a compact, self-contained unit which develops 800-lb force at ¼-in. stroke with 80-lb preload. Only 2 in. long, spring uses internal hydraulic levering principle to produce high force. Unit with optional built-in



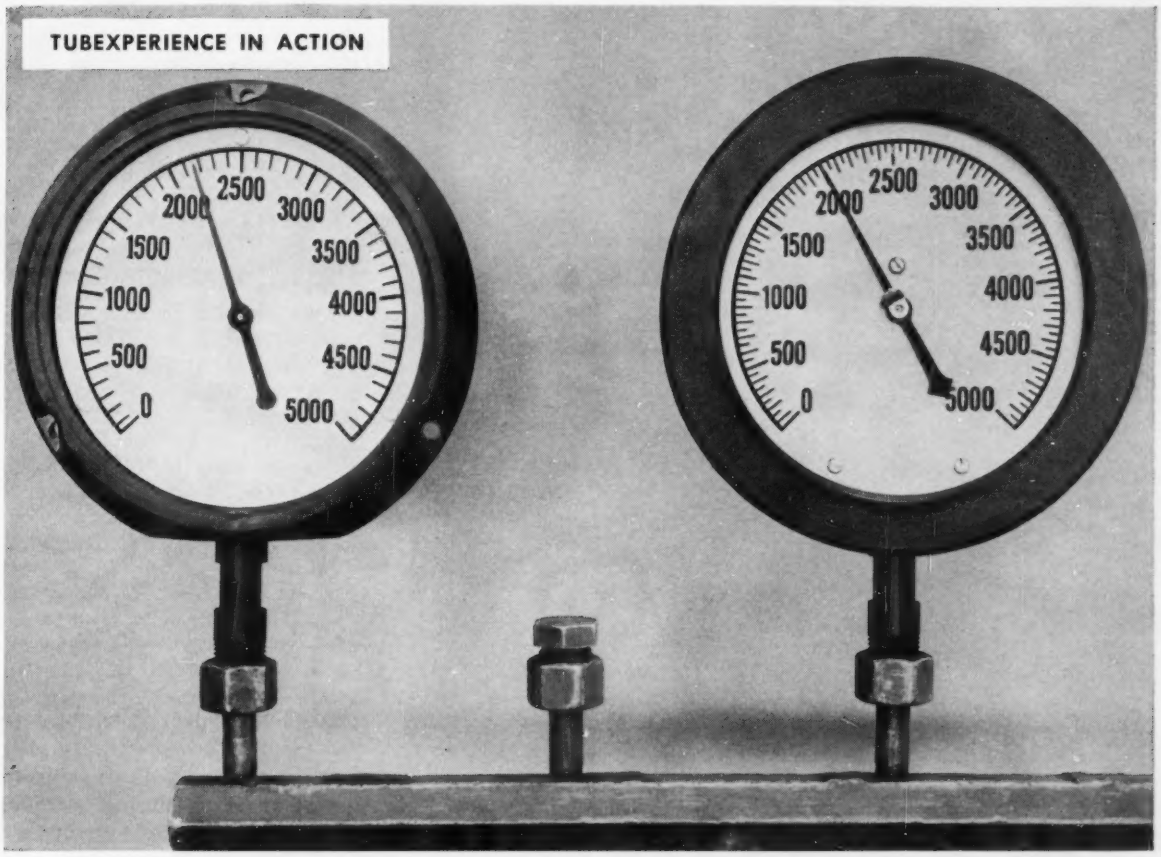
shock absorber is available. Spring has standard ⅜-24 mounting thread. **Taylor Devices Inc.,** 188 Main St., North Tonawanda, N. Y.

Circle 745 on page 19

Terminal Board Units

utilize Teflon cork terminals

Glass-reinforced plastic sheet and Teflon are the basis of new terminal board units providing im-



Q. Which gage tells the truth longer?

A. *The gage with the Superior extra-quality Bourdon tube*

HERE'S WHY—

Quality cannot be inspected into tubing. Thus at Superior the quality is built in from start to finish. Stock for redrawing is carefully selected and prepared. Superior's method of producing Bourdon tubing includes many special techniques, developed through years of "tubexperience." Such factors as surface quality, close dimension control, freedom from decarburization, accurate shaping and cleanliness, all combine to produce a Bourdon tube of unexcelled quality.

Cheap Bourdon tubing no economy. Why risk having your gages fail or lose their accuracy? Inferior quality Bourdon tubing will crack, develop leaks, or take a set long before Superior's will show any signs of wear.

Quality Bourdon a must. The Bourdon tube represents only a small fraction of the total cost of your gage, yet it is the most important single element. Be sure to get only the best Bourdon tubing available.

Specify Superior. There are 8 different Bourdon analyses to choose from, including Ni-Span C. Flat ovals, ellipticals, rounds and partial rounds, etc. For technical data on Superior extra-quality Bourdon tubing, write for a free reprint of "Bourdon Elements Require Special Tubing." Superior Tube Company, 2010 Germantown Ave., Norristown, Pa.

Superior Tube

The big name in small tubing

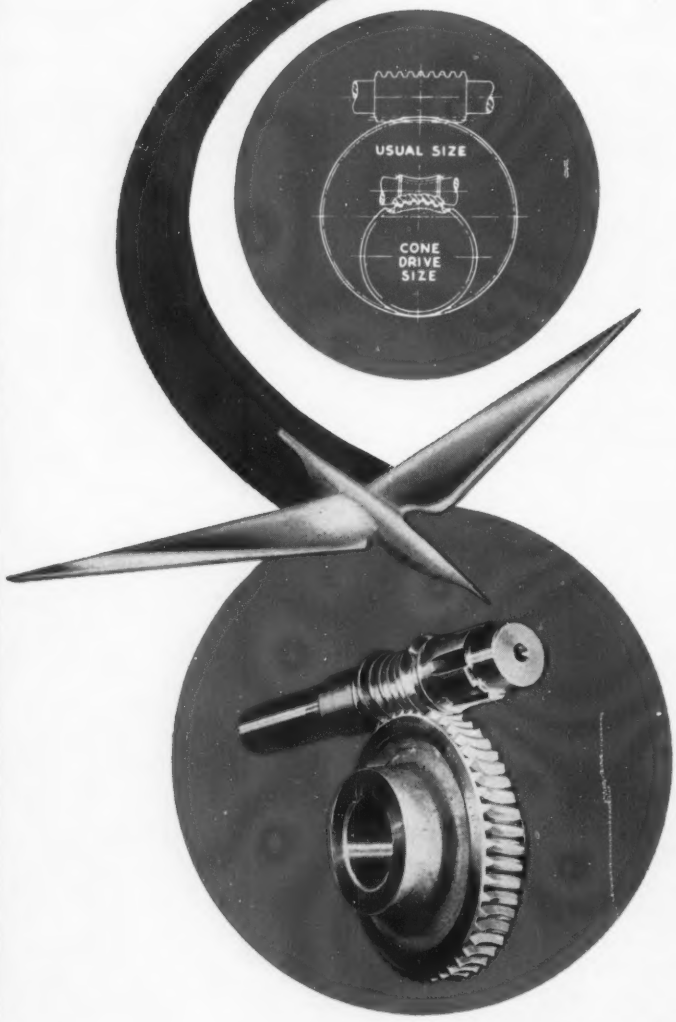
NORRISTOWN, PA.

All analyses .010 in. to 5/8 in. OD—certain analyses in light walls up to 2½ in. OD

West Coast: Pacific Tube Co., 5710 Smithway St., Los Angeles 22, Calif. • RAymond 3-1331

Circle 511 on page 19

if you're looking for
smooth power



. . . CONE-DRIVE gearing has no equal.

You can drive the most delicate equipment or the heaviest industrial machinery without vibration or noise through a set of Cone-Drive gears.

Smooth delivery of power is an outstanding feature of Cone-Drive double-enveloping worm gearing. It's the result of a unique design that puts one-eighth of all gear teeth in simultaneous, full-depth contact with the worm threads.

The contact between teeth is "area" rather than the line or point type contact found in cylindrical worm gearing. This distributes the load over more area on each tooth to boost load-carrying capacity.

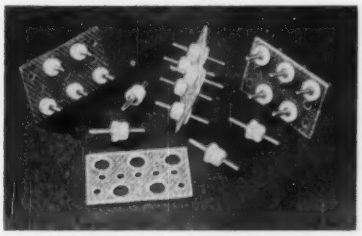
Want smooth, chatter-free, efficient power in a compact package? Cone-Drive gears will give it to you in gearsets or speed reducers in a wide range of models and sizes.

Ask for Bulletin 600-C for details.

CONE-DRIVE GEARS
Division, Michigan Tool Company

DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
7171 E. McNICHOLS ROAD • DETROIT 12, MICHIGAN

Circle 512 on page 19



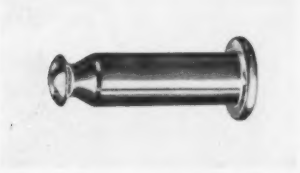
proved electrical and mechanical characteristics. Application is in miniaturized components for avionics, complex military communications and control systems. Temperature limits range from −65 to 250 F and shock loads are in excess of 10 *g*. High thermal, electrical and shock-resistance characteristics of reinforced plastic permit size reduction of boards to subminiature size. Plastic board, which is 1/64 in. thick, is readily punched to receive Teflon-insulated terminals which are corked into closely spaced openings. **Tri-Point Plastics Inc.,** 175-177 I. U. Willets Rd., Albertson, L. I., N. Y.

Circle 746 on page 19

Titanium Rivets

for aircraft and missile applications

Combining light weight with high strength, titanium rivets are for aircraft and missile applications under extreme environmental con-



ditions. They are available in a full range of sizes. **Hi-Shear Rivet Tool Co.,** 2600 W. 247th St., Torrance, Calif.

Circle 747 on page 19

Motors

are redesigned balancing and chart-drive units

Chart-drive and two-phase balancing motors are used in recorders, indicators, and controllers. Design incorporates series of four die-cast aluminum housings bolted together into a square assembly, a printed circuit that lengthens

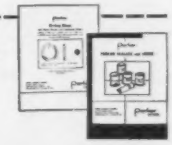
Prove by comparison tests that Parker O-rings seal better, last longer

Comparison tests will prove it. You can't *see* the difference. You can't *feel* it. But in *use,* Parker O-rings seal better, last longer.

Why? Because Parker O-rings are precision-molded of superior compounds developed by exhaustive research and experimentation. Our engineering service will help with your problems — whether in gland design or compound. From Parker, you get the *right* O-ring for your *specific* application.

These trouble-free, leakproof seals are carefully evaluated for elongation, tensile strength, compression set ratings, resistance to oils, fuels, chemicals and temperature extremes. Exacting laboratory and service tests make sure that Parker O-rings meet applicable specifications. Whatever your requirements, Parker can supply the O-rings you need.

Parker O-Lube is especially formulated for O-ring lubrication requirements. It comes in a handy, squeeze-tube container.



RUBBER PRODUCTS DIVISION, Section 526-V,
The Parker Appliance Company,
17325 Euclid Avenue, Cleveland 12, Ohio.
1538 South Eastern Ave., Los Angeles, Cal.

Please send:

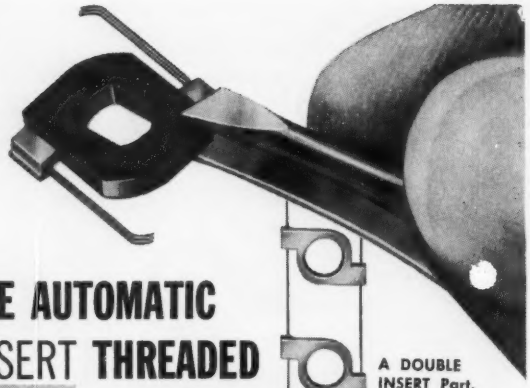
☐ O-ring Size Catalog No. 5701
☐ O-Lube Catalog No. 5840

NAME _____ TITLE _____
COMPANY _____
ADDRESS _____
CITY _____ STATE _____

Parker
Hydraulic and fluid system components

Circle 513 on page 19

another wonderful GRC idea for designers

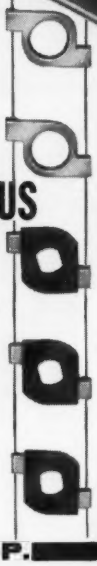


GRC's UNIQUE AUTOMATIC METHODS INSERT THREADED PIECES, WIRES, even CONTINUOUS ELEMENTS, RIGHT IN THE MOLDING OR CASTING CYCLE

Fast . . . economical, GRC's exclusive automatic machines insert elements in zinc alloy die castings . . . in thermoplastic moldings, assure uniformity, eliminate assembly . . . make possible entirely new designs . . . cut labor and costs.

Write for bulletins, send prints for quotation.

No size is too small! Maximums: Zinc Alloy 1½", ½ oz. Plastic 1¼", .03 oz.



A DOUBLE INSERT Part, automatically produced

For this IBM Brush Assembly, the core is die cast automatically and continuously onto 6 strands of music wire on each side.

In the second cycle the nylon insulating jacket is molded automatically and continuously . . . right onto the die cast core and wire inserts.

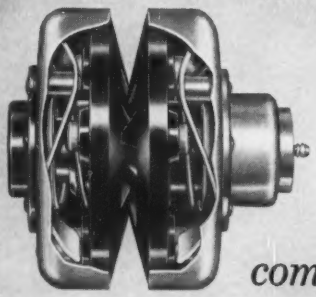
GRIES REPRODUCER CORP.

World's Foremost Producer of Small Die Castings

32 Second St., New Rochelle, N. Y. • NEw Rochelle 3-8600

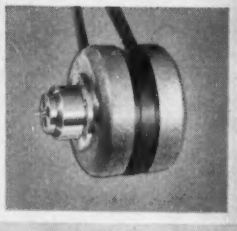
Circle 514 on page 19

DESIGN-WISE...



this simple pulley solves complicated problems

Compactness of *HI-LO* automatic variable speed pulleys simplifies basic machine design in a vast range of applications. The exclusive design of cam followers on cams provides simple, positive pitch diameter setting control. Springs in HI-LO pulleys are not driving members as in most spring-loaded pulleys, but serve primarily to keep the pulley faces in contact with the belt. Belt wear is reduced to a minimum because the belt is never under any more tension than is required by the load. Free technical manuals with diagrams, descriptions of applications and other power transmission data are available from:



Equipment Engineering Company

2855 Columbus Ave., Minneapolis, Minnesota

Circle 515 on page 19

New Parts

life of coil connections, and felt wicks that prevent leakage of lubricating oils. One casting contains the stator and another the gear box, while two serve as retainers for bearings at each end of rotor. Two-phase induction motors have no-load shaft speeds of

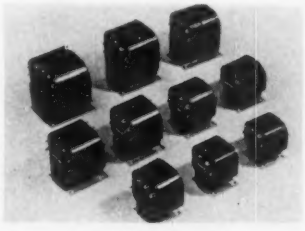
330, 148, 44, and 22 rpm and maximum starting torques from 10 to 120 oz-in. Synchronous chart-drive motors with speeds of 180, 90, 60, and 30 rpm have torques from 12 to 25.5 oz-in. **Minneapolis-Honeywell Regulator Co.,** Industrial Div., Wayne & Windrim Aves., Philadelphia, Pa.

Circle 748 on page 19

Molded Transformers

for airborne applications

Ten sizes of molded transformers are available for standard and high-temperature airborne applications. Units range from 0.2 to 1.5 lb. Smallest unit, Type M1, is 1¾ x 1⅝ x 2 in. in size. Largest transformer, Type M 10, measures



2 13/16 x 2⅞ x 3 in. Unit meets MIL-T-27A Grade 2 and Grade 5 tests. **United Transformer Corp.,** 150 Varick St., New York 13, N. Y.

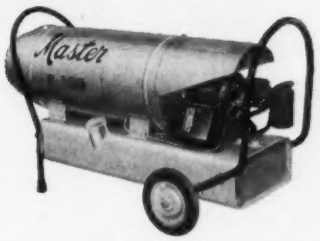
Circle 749 on page 19

Packing

has low coefficient of friction

Rodpak is a metallic, piston, or rod-type packing which uses the principle of pressure sealing. Rub-

Master B-100 Portable Space Heater
MANUFACTURED BY MASTER VIBRATOR COMPANY DAYTON, OHIO



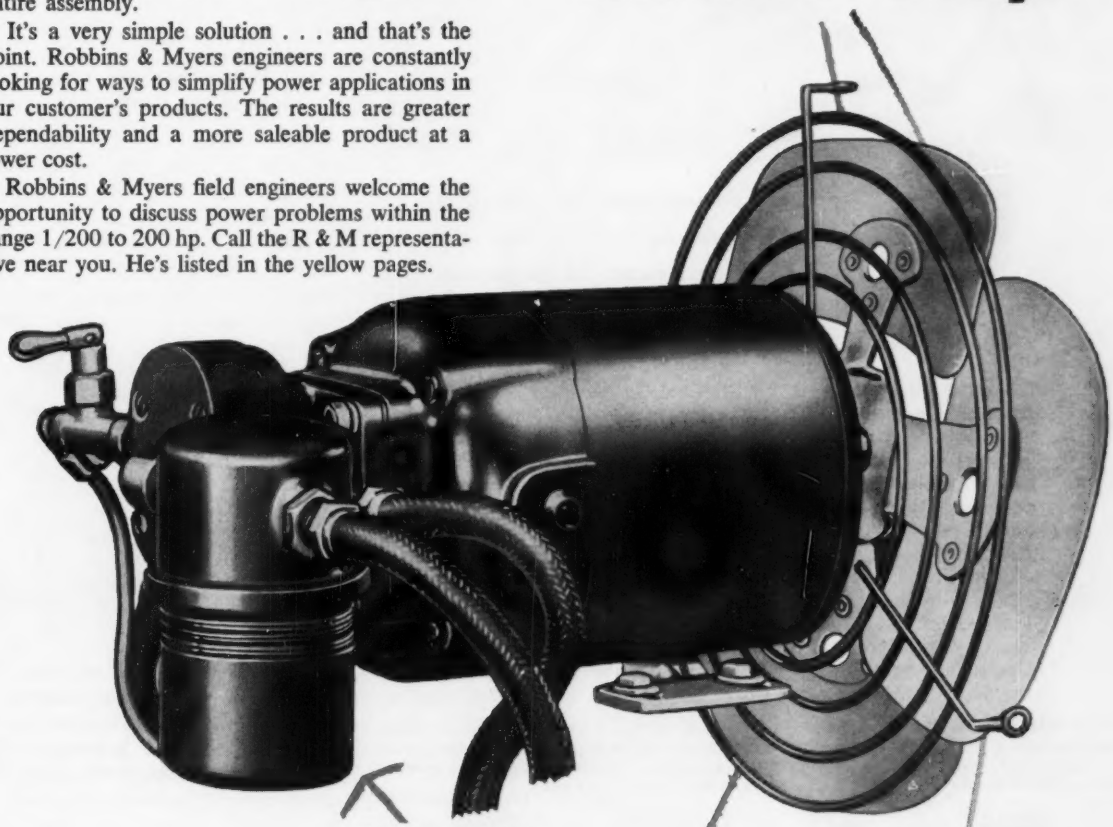
R&M motor does double duty

To accomplish compactness, simplicity and lower cost, this enclosed ¼ hp., 3450 rpm split phase Robbins & Myers motor was specially designed to do two important jobs in the Master B-100 Portable Space Heater.

A special face mounting accommodates a direct driven fuel pump. The other end of the shaft drives a direct connected fan with an output of 430 cfm. A rigid foot mounting on the motor supports the entire assembly.

It's a very simple solution . . . and that's the point. Robbins & Myers engineers are constantly looking for ways to simplify power applications in our customer's products. The results are greater dependability and a more saleable product at a lower cost.

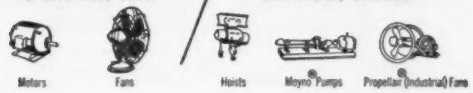
Robbins & Myers field engineers welcome the opportunity to discuss power problems within the range 1/200 to 200 hp. Call the R & M representative near you. He's listed in the yellow pages.



One end of shaft drives fuel pump attached to special end mounting.

Other end of the shaft drives a direct connected 430 cfm fan.

ROBBINS & MYERS, INC.
SPRINGFIELD, OHIO / BRANTFORD, ONTARIO



Circle 516 on page 19

THE MARK OF QUALITY

BARBER COLMAN

Small Motors

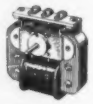
TYPE DYAZ

"We needed a dependable geared synchronous motor for accurate chart drive on our Monitorecord"

Sheffield Corporation, Dayton, Ohio

The new "Monitorecord" by Sheffield Corporation, Dayton, Ohio, times and records simultaneous and sequential operational events of automatic machines and devices. Capable of monitoring up to 14 separate operations simultaneously, this instrument provides a split-second recording of each operation as the equipment starts, runs, and stops. Scribed time lines appear on a strip chart. To accurately drive this chart, Sheffield Corporation selected the Barber-Colman DYAZ geared synchronous motor. "Plus" features of this geared motor include double-supported gear shafts with sintered bronze bearings . . . extra large oil wicks . . . helical pinion and gear in first step . . . heavy-duty gears and output shaft. If you have a design problem involving small motors, let Barber-Colman Company engineers help you solve it with the exact motor for the job.

FREE HELPFUL DATA SERVICE on the complete line of Barber-Colman small motors, which includes unidirectional, synchronous, and reversible motors up to 1/20 hp. With or without reduction gearing . . . open or enclosed types. Expert engineering service available. Write today, outline your problem, ask for free data sheets and Catalog F-4271, or see Sweet's Product Design File.



REVERSIBLE

SYNCHRONOUS

GEARED

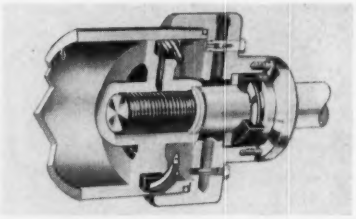
UNIDIRECTIONAL

BARBER-COLMAN COMPANY

Dept. U, 1273 Rock Street, Rockford, Illinois

Small Motors • Automatic Controls • Industrial Instruments • Aircraft Controls
Electrical Components • Air Distribution Products • Overdoors and Operators
Molded Products • Metal Cutting Tools • Machine Tools • Textile Machinery

New Parts



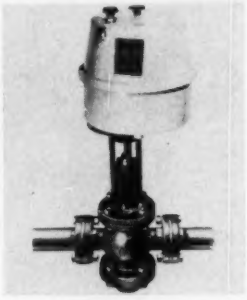
ber housing ring seats soft metal against cylinder walls or piston rods. Close seal is formed, with soft metal rings impressing themselves into any irregularities of walls and pistons. Packing has low coefficient of friction and eliminates scoring of rods or cylinder walls. **Remco Mfg. Co.,** 1006 Lakeville Highway, Petaluma, Calif.

Circle 750 on page 19

Valve Actuator

for valves requiring less than 200-lb thrust

New valve actuator operates from signals supplied by a controller, remote positioning device or directly from measuring element. Self-contained unit is designed for valves with from ½ to 1½ in. full stroke which require less than 200-lb thrust. Standard signal



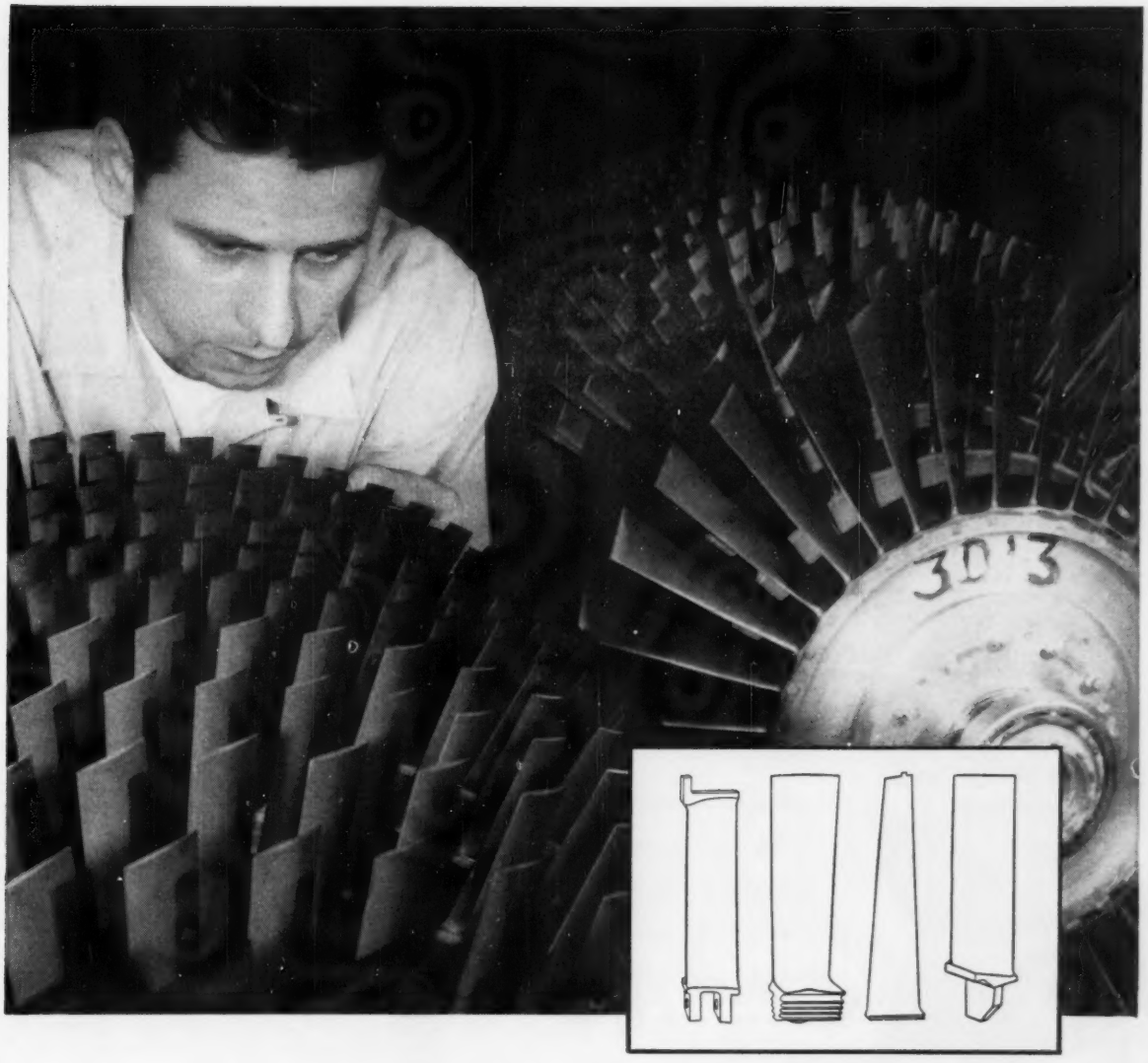
range is from 1 to 5 or from 4 to 8 ma dc. An internal rectifier is supplied with the actuator for ac signals. **Askania Regulator Co.,** 240 E. Ontario St., Chicago 11, Ill.

Circle 751 on page 19

Magnetic Brake

is miniature spring-set unit

No. 2SC magnetically released, spring-set miniature brake is designed for direct-current application and is wound for 28 v. Metallic bonded friction lining provides



Curtiss-Wright **PROTOTYPE SERVICE** speeds you from blueprint to working model

Here's the fast, efficient and economical way to get working models from your turbine or compressor blade designs . . . whether you want a single prototype or test production quantities. Curtiss-Wright's Metals Processing Division scales down its complete facilities in a modern, geared-to-speed prototype shop . . . brings under one roof all the production steps from primary metal to finished product in any high integrity alloy.

Working model production brought to a fine point of precision control means more accurate development now . . . smoother flowing production later. Coordinated facilities for casting, forging, grade rolling, machining and extrusion are ready to serve you on short notice . . . solve your problems in a hurry. Contact Curtiss-Wright when your next set of designs leaves the drafting board. Qualified engineering consultation available at all branch offices.

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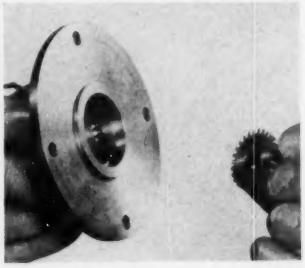
Circle 518 on page 19

MEMO
TO J. C.
FROM R. K.
They make all types. How about getting their (UNION'S) recommendation on chain.
We say you should. Since we make all types of steel drive and conveying chain plus sprockets and attachments our engineering experience is naturally broad and our recommendations are just as naturally unprejudiced. Let the Union Chain organization work for you.
TRANSMIT POWER
UNION CHAINS
CONVEY MATERIALS
The Union Chain And Manufacturing Company
SANDUSKY, OHIO

New Parts

long wear, high torque and thermal capacity. Brake has application on computers, antenna control for radar, and valves on



atomic reactors. Torque rating is 25 oz-in. Unit is 2 in. long and has diameter of 1⅜ in. **Stearns Electric Corp.**, 120 N. Broadway, Milwaukee 2, Wis.

Circle 752 on page 19

Saturating Base Paper

for industrial and electronic laminates

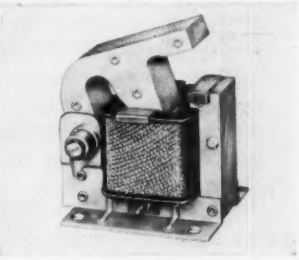
Grade 101 saturating base paper, for electronic laminates and other applications requiring high absorbent capacity, is extremely uniform in weight and thickness. High alpha cellulose content provides excellent absorbency rating of 15/16 in. to 1¼ in. water rise in 1 min (Klemm capillarity test). Paper is available in rolls to maximum width of 80 in., in black, white, and colors. **Knowlton Brothers Inc.**, 215 Factory, Watertown, N. Y.

Circle 753 on page 19

Rotary Solenoid

has only one moving part

Rotosol, a rotary solenoid for ac operation, employs a magnetic circuit that permits operation under load over wider fluctuation in voltage. Permissible angle of rotation at which work can be performed is up to 70 deg. Torque



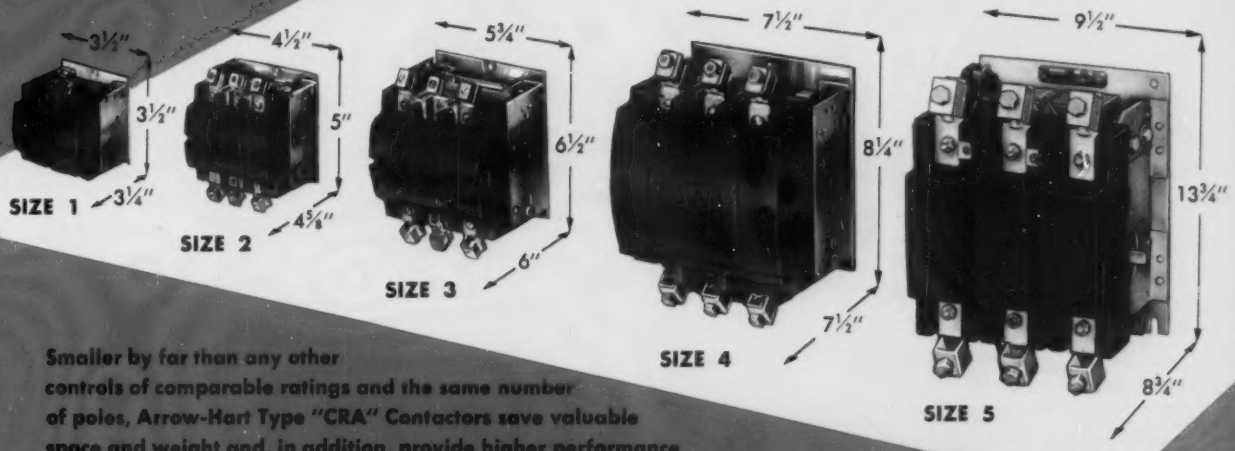
Circle 519 on page 19

Circle 520 on page 19→

ARROW AH HART

POWER CONTACTORS

give you FINER PERFORMANCE in HALF the size



Smaller by far than any other controls of comparable ratings and the same number of poles, Arrow-Hart Type "CRA" Contactors save valuable space and weight and, in addition, provide higher performance standards with greater dependability, longer life and faster, easier installation and maintenance. Available in a complete line — from Size 0 to Size 5 — they provide the right control for all your requirements.

CONSTRUCTION FEATURES - -

Straight-Thru Wiring is quickly, easily accessible from the *front*. Double break contacts, of silver cadmium oxide for weld resistance on high inrush currents, are accessible from the front for fast, simple inspection or replacement. Molded AC operating coils resist moisture and dirt . . . normally last the life of the relay itself. Resinox base and hood provide maximum arc and tracking resistance.

OPERATING FEATURES - -

Magnets are designed for high-efficiency, low wattage operation. Exclusive mechanical design – available only on Arrow-Hart Controls – has proved its ability to operate dependably under the most adverse conditions.

EXTRAS AVAILABLE - -

If required, Arrow-Hart Type "CRA" Contactors can be supplied with: NEMA Type I, IV, VII, IX & XII Enclosures. Sizes 0, 1 & 2 can be supplied with coils & magnets for up to 250 volts DC.

"CRA" SELECTOR GUIDE

"CRA" UNIT	POLES	AUXILIARY HOLDING SWITCH	CONTINUOUS RATINGS IN AMPERES	EXTRA AUXILIARY SWITCHES
Size 0	2-5, N.O.	Optional	18	Yes
Size 1	2-5, N.O.	Optional	27	Yes
Size 2	2-5, N.O.	Yes	45	Yes
Size 3	2-5, N.O.	Yes	90	Yes
Size 4	2-5, N.O.	Yes	135	Yes
Size 5	3-5, N.O.	Yes	270	Yes

RESISTIVE HEATING LOADS (KW)

"CRA" UNIT		A-C VOLTAGE			
SIZE	PHASE	115	230	440	550
1	1	2.5	5	10	12.5
	3	4	8	17	21
2	1	5	10	20	25
	3	8.5	17	34	43
3	1	10	20	40	50
	3	17	34	68	86
4	1	15	30	60	75
	3	26	52	105	130
5	1	30	60	120	150
	3	52	105	210	260

HORSEPOWER RATINGS

"CRA" UNIT		A-C VOLTAGE		
SIZE	PHASE	110	220	440/550
0	1	1	2	3
	3	2	3	5
1	1	2	3	5
	3	3	7½	10
2	1	3	7½	10
	3	7½	15	25
3	1	7½	15	25
	3	15	30	50
4	3	25	50	100
5	3		100	200

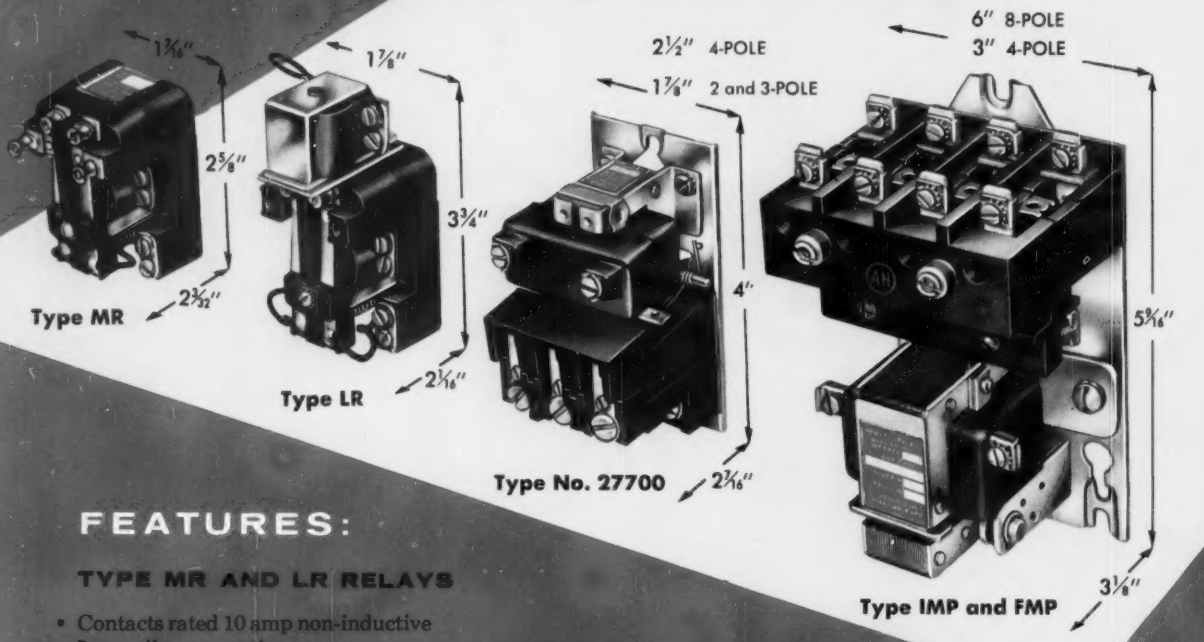
PLEASE TURN THE PAGE FOR ADDITIONAL INFORMATION . . .

ARROW AH HART

RELAYS

have EVERY feature you want --

LONG LIFE, ADVANCED DESIGN, VERSATILITY



FEATURES:

TYPE MR AND LR RELAYS

- Contacts rated 10 amp non-inductive
- Low coil consumption
- Contacts have wipe action
- A, B and C type contacts available
- Available 1 to 4 poles
- Coils available in all common A.C. or D.C. voltages
- Exceptionally long life
- Type LR – Latch-in or Latch-out or both

HEAVY DUTY RELAY, Type 27700

- Ideal for the new, heavy duty commercial appliances
- 20 amps per pole at 300V A.C.
- 120 amps interrupting capacity
- Coil inrush 12 watts (Approx.)
- Coil sealed 2.5 watts (Approx.)
- Available 2, 3 or 4 poles A.C.

TYPE IMP AND FMP

- Size 00 and 0 for operation to 600V A.C. or 250V D.C.
- Available with 2, 3, 4, 6 or 8 poles
- Instant interchangeability of contacts – no disassembly or reassembly of contacts
- Plug-in receptacle available for all sizes
- Latch attachment can be added by user
- Latch is convertible to latch-in or out or both
- Same coil and magnet regardless of number of poles

USE THIS COUPON TO SEND FOR COMPLETE INFORMATION ON ARROW-HART RELAYS AND POWER CONNECTORS

AH

THE ARROW-HART & HEGEMAN ELECTRIC COMPANY

103 Hawthorn Street, Hartford 6, Connecticut • Motor Control Division

Please send me complete engineering data on:

☐ Type "MR" and "LR" Relays ☐ Type "IMP" and "FMP" Relays

☐ 20-Ampere Relays ☐ Type "CRA" Contactors

☐ I am also interested in other industrial motor controls.

name _____

position _____

company _____

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city _____ zone ____ state _____

MD

ARROW AH HART

Quality since 1890

WIRING DEVICES • MOTOR CONTROLS • ENCLOSED SWITCHES • APPLIANCE SWITCHES

Branch Offices and Sales Engineers Throughout the United States.

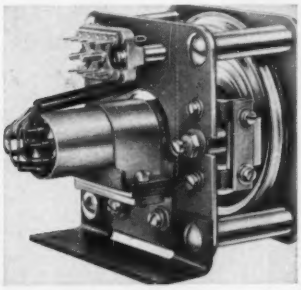
produced by electromagnetic circuit increases as angle of rotation decreases. A unit with only one moving part, solenoid uses a magnetic coil wound on a molded phenolic bobbin. Coil can be removed and replaced without disassembly of entire unit. Sizes are rated from 2 oz-in. to 150 lb-in. starting torque. **Roto Mfg. Co.,** 1030 W. Second St., Xenia, Ohio.

Circle 754 on page 19

Pressure Transducer

for use in data-reduction systems

Pressure transducer, for use in data-reduction systems, converts a 3 to 15-psi signal to ac millivolts directly proportional to pneumatic input. When pressure is applied to transducer sensing element, re-



sulting movement of expandable capsule displaces an armature which induces opposing voltages in twin secondary coils. Voltage is linearly proportional to pressure input. Output can be used to position an indicator, recorder or control device. Accuracy is 0.25 per cent of full scale. **Fischer & Porter Co.,** 93 Jacksonville Rd., Hatboro, Pa.

Circle 755 on page 19

All-Nylon Filters

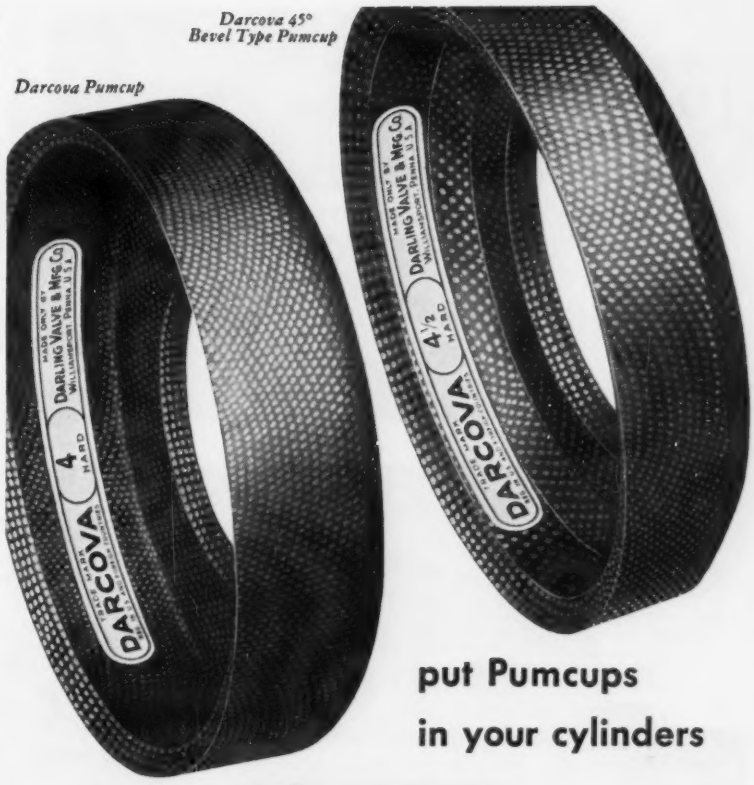
withstand rust and corrosion

Filters are molded in types, sizes and shapes to meet specific filtering requirements. One-piece nylon moldings with nylon mesh and supporting structural frame are injection-welded together in a permanent bond. Units filter lube, diesel and hydraulic oils, water, gasoline, insecticides, cutting oils

(*Please turn to Page* 220)

Darcova 45° Bevel Type Pumcup

Darcova Pumcup



put Pumcups in your cylinders

TO HOLD PRESSURE LONGER!

In Darcova Pumcups a sound engineering principle has been combined with precision tolerances and extremely durable compositions to provide exceptional efficiency and life in hydraulic, air, and reciprocating pump cylinders of all kinds.

Unlike ordinary piston packing, precision Pumcups are engineered to minimize friction load while hugging cylinder walls on every pressure stroke. Regardless of eventual wear, efficiency *stays* high! So there's far less down-time and need for replacement.

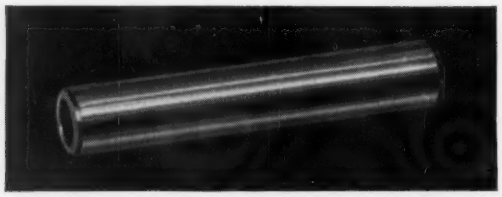
Pumcups are made in a wide range of sizes, types and texture-engineered compositions, including 100% Nylon, for all kinds of pressure-temperature-fluid conditions. Send for Pumcup Bulletin 5503 and weigh all the facts!

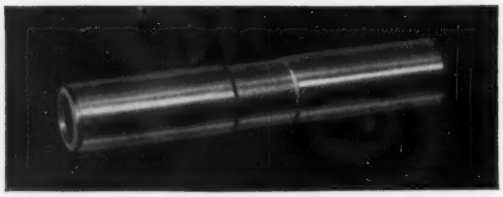
DARLING VALVE & MANUFACTURING CO.
Williamsport 30, Pa.

DARCOVA
THE ORIGINAL COMPOSITION CUP
TRADE MARK
PUMCUPS

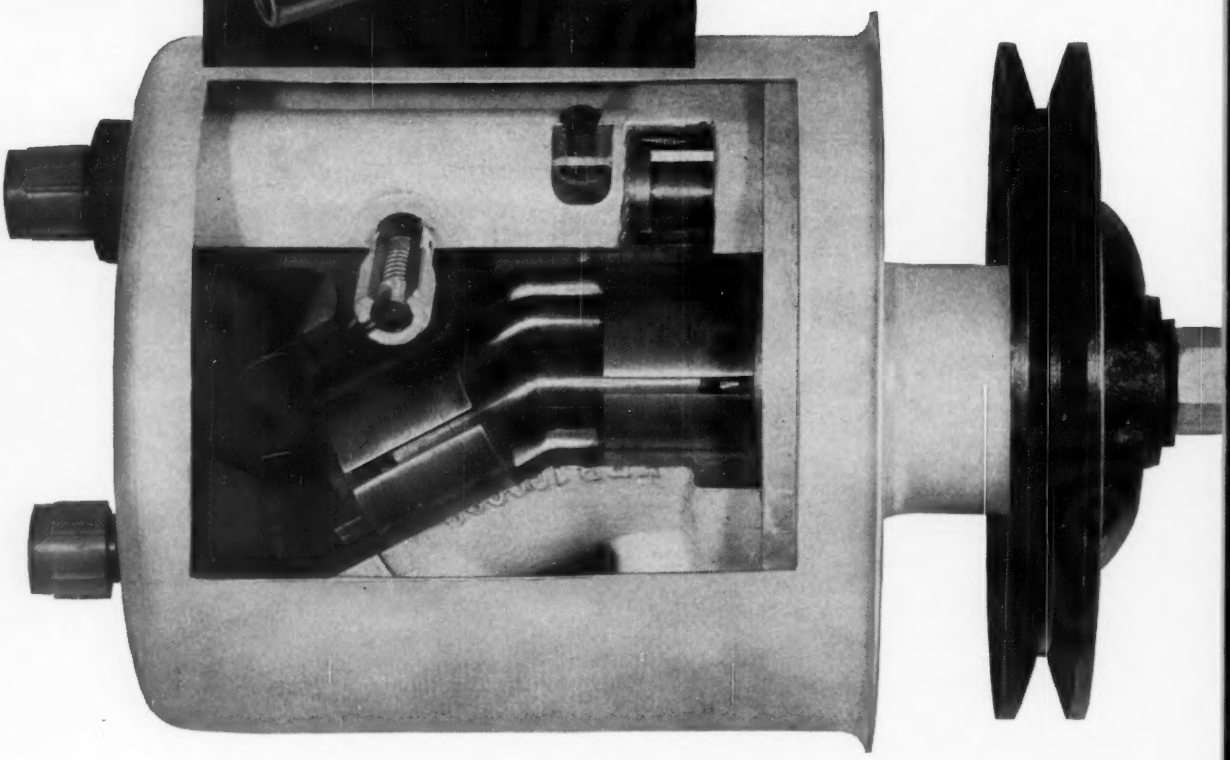
Circle 521 on page 19

Republic





Unusual ductility and uniformity of Republic ELECTRUNITE Mechanical Tubing makes possible the assembly of this automotive hydraulic power pump, designed and assembled by Thompson Products, Inc. Finished O.D. is to ± .0003 inches.



REPUBLIC

REPUBLIC STEEL

World's Widest Range of Standard Steels

ELECTRUNITE Mechanical Tubing

meets all close tolerance requirements for new Thompson Products Automotive Pump!

Close tolerance, uniformity, ductility, workability—four important performance requirements, all reasons why Republic ELECTRUNITE Mechanical Tubing is used in a new automotive hydraulic power pump assembly.

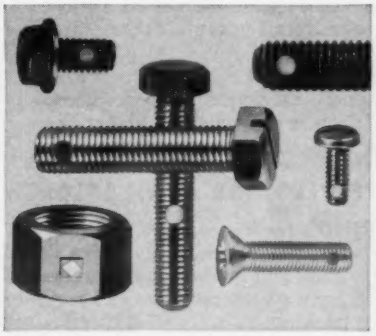
Designed and assembled by Thompson Products, Inc., Cleveland, Ohio, this pump furnishes power for power steering featured by a nationally famous automobile manufacturer.

Will-O-Hill Industries, Inc., Willoughby, Ohio, subcontractor, manufacturers, and specialists in close tolerance tubular stampings, cut $\frac{7}{16}$-inch-diameter Republic ELECTRUNITE Mechanical Tubing into units $2\frac{3}{16}$ inches long. Each unit is rolled to form a slight groove in the center, and bent to an angle of exactly 150°. Nine such pieces are used in each pump assembly.

Both ends are subsequently bent in a die, held to a tolerance of ± .0005 inches and finished with an O.D. to ± .0003 inches. This close tolerance represents outstanding workability, using manufactured tubing as base stock.

This is another example of how Republic engineers are able to work with you in solving precision problems and reducing costs through the unusual uniformity and ductility of Republic ELECTRUNITE Mechanical Tubing. For additional information, send coupon or write today!

UNIFORM ROUNDNESS AND SURFACE FINISH are reasons why Republic Manufacturers Wire is specified for the most difficult fabrication requirements. Up-to-date machinery and methods, skilled laboratory control, and careful inspection, assure every purchaser of a material that will suit his specific needs. Manufacturers producing a wide variety of items have found Republic Wire a valuable aid in minimizing losses, stepping up production, and increasing the salability of their products. Mail coupon for complete details.



MEET SEVERE REQUIREMENTS for maximum holding power with Republic Nylok Bolts and Nuts, specifically designed for bolted assemblies that must be vibration-proof and adjustable. Resilient nylon insert permanently embedded in the fastener provides re-usability, eliminates lost motion of assembling extra locking devices. Nylok Bolts and Nuts can be either hand or power wrenched. Republic offers manufacturers more than 20,000 standard and 8,000 special types and sizes of fasteners to meet practically any fabrication-assembly.

GREATER MACHINABILITY, better surface finish, higher strength, are a few of the over-all economies of using Republic Cold Finished Steel Bars for machine parts. This high-accuracy .22-caliber target pistol, made by the High Standard Manufacturing Corporation, Hamden, Connecticut, represents the ultimate in target pistol performance, winning honors in championship matches throughout the world. Republic Cold Finished Steel Bars, used for barrel stock in this pistol and other High Standard firearms, meet their most exacting specifications.

STEEL

and Steel Products

REPUBLIC STEEL CORPORATION
DEPT. C-4344
3130 EAST 45TH STREET • CLEVELAND 27, OHIO

Please send me the following information:

- ☐ Republic ELECTRUNITE® Mechanical Tubing
- ☐ Republic Cold Finished Steel Bars
- ☐ Republic Nylok® Bolts and Nuts
- ☐ Republic Manufacturers Wire

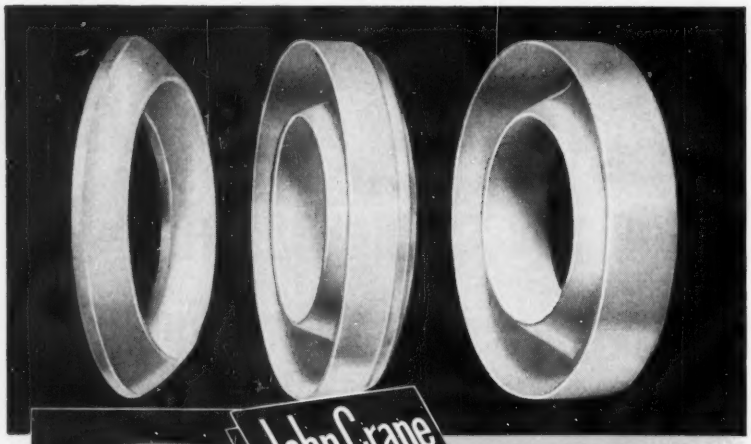
Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

Circle 522 on page 19



John Crane

CHEMLON *

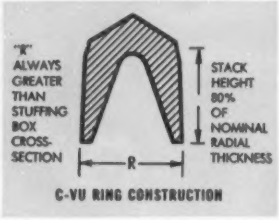
C-V RINGS

ARE INDUSTRY'S MOST UNIVERSAL PACKING . . .

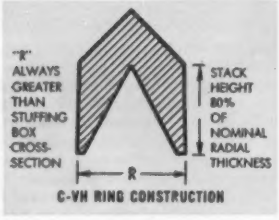
Countless successful applications of C-V Rings under the most severe service conditions have made this the closest approach to a universal packing.

It will effectively handle all industrial acids, alkalis, solvents, organic and hydraulic fluids . . . temperatures from −120°F. to +500°F. . . . is equally suited to valves, pumps, mixers, hydraulic cylinders and like equipment.

"John Crane" C-V Rings have extremely low coefficient of friction. "Breakout" friction is only slightly higher than running friction.



C-VU RING CONSTRUCTION



C-VH RING CONSTRUCTION

TWO STYLES ARE AVAILABLE:

C-VU RINGS *for low pressure service* —such as control and regulator valves handling gases and fluids, where it is necessary to have a very sensitive and resilient type packing.

C-VH RINGS *for high pressure service* —for use in pumps, hydraulic cylinders and like services at pressures ranging to 500 psi. and over. These rings are constructed with a heavy wall heel to withstand pressure requirements. They are designed to provide voids between rings, so that as the Teflon expands due to heat, this take-up room minimizes any excess friction in the stuffing box.

"John Crane" C-V Rings are available in full line of standard sizes and male and female adaptors. Sizes can be molded to stuffing box specifications.

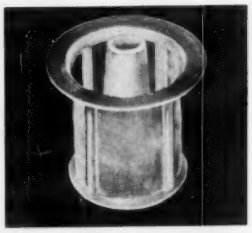
Request Bulletin P-325.

*"John Crane" C-V Rings are made from Chemlon—*the best in DuPont Teflon.*

Crane Packing Co., 6425 Oakton St., Morton Grove, Ill. (Chicago Suburb). *In Canada: Crane Packing Co., Ltd., Hamilton, Ont.*

New Parts

(*Continued from Page* 217)



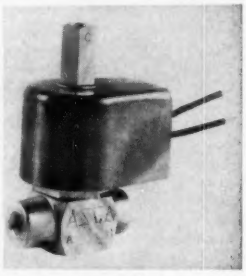
and air. They withstand rust and corrosion. **Danielson Mfg. Co.,** Industrial Products Div., Danielson, Conn.

Circle 756 on page 19

Solenoid Valve

miniature unit has 0 to 300-psi pressure range

Three-way miniature solenoid valve line has been expanded to include ¼ as well as ⅛-in. pipe connections. Greater pressure range is from 0 to 300 psi. Four constructions available include: Universal type (pressure at any orifice); normally closed type (air service only, valve vents to atmosphere); normally closed type (air and liquids); normally open type (air and liquids). Brass or stainless-steel bar-stock bodies and crown-type seats, integral with valve bodies, supply inherent seat alignment with no leakage. Valve



operates in any position, on voltages to 550 v ac, 25 cycles, 250 v dc. **Automatic Switch Co.,** Florham Park, N. J.

Circle 757 on page 19

Magnetic Contact Relay

has self-contained reset mechanism

Model 281 10-ma magnetic contact relay withstands more than 500 *g* shock and vibration of 5 to 55 cps at 0.060 in. amplitude. Insulation

Any similarity to a real-life company is purely intentional

How did the lathe builder get the worm to turn?

Henry Wadsworth Headstock had a dream. About a better turret lathe. It used worm gears in the drives.

He not only doodled it — he dood it. And he got a venturesome soul to try out a pilot model of his new Turnabout Lathe.

Then his troubles started to multiply — like ants at a picnic. For the worm gears conked out with a sickening regularity. There were 12 replacements in 24 weeks. (Three guesses what the big wheels thought of *that!*) Things certainly were in one heck of a mesh.

Then Henry heard of Ampco Metal, the special copper-base alloy. And he had a worm gear made out of *it*. The last we heard, the Ampco Metal gear had been running for a whole year and still showed no signs of wear.

Frankly, we're not surprised. Gear service — in fact, *any* wear application — is duck soup for Ampco Metal. It resists deformation under heavy loads and speeds — so tooth contours hold their original shape. There's no scoring, no galling — the worm has true bearing action against the worm wheel. Damping characteristics, plus fine mating properties, reduce the noise of the gear set.

The moral is obvious: Why gamble with guesses on gear life (or other critical parts), when it's so easy to be *sure*.

If you want to know more about Ampco Metal, call in your Ampco field engineer. Write for Bulletin 33. *Ampco Metal, Inc., Dept. MD-9, Milwaukee 46, Wisconsin. (West Coast Plant: Burbank, California)*

AMPCO® METAL *The metal without an equal*

0-2

Mr. Design Engineer –

Here are BRAND NEW units for improving efficiency of pneumatic operation

— new designs
— new features
— new **HIGH EFFICIENCY**

(introduced by WATTS, leader in flow control specialties since 1875)

Delivers really CLEAN dry air

Watts Filter delivers clean dry air to Federal Products Dimensionair.

High-Efficiency FILTER with exclusive "Tornado Action."

Extreme centrifugal force spirals dirt and moisture particles downward into the "quiet zone" leaving in the air only a minute percentage of the finest and lightest particles which are trapped by the filter cone.

Maintains MORE UNIFORM PRESSURE

Watts Regulator maintains uniform air pressure for Scott-Williams KN Knitting Machine

High-Efficiency REGULATOR with highly sensitive "Aspirator Action."

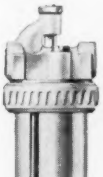
Watts Aspirator control acts directly on the diaphragm, giving instant compensation for fluctuating pressure demands . . . provides precise control and stabilizes pressures reaching individual pieces of equipment.

LUBRICATES perfectly at all flow rates

Watts Lubricator provides efficient lubrication for Markem Machine Company's Model 70AF.

High-Efficiency LUBRICATOR with exclusive "By-pass pick-up."

Watts new By-Pass Pick-Up makes possible a sub-miniature, high velocity venturi section which positively creates sufficient force — even at flow rates as low as one cubic foot per minute — to vaporize oil into a fine mist for uniform, economical lubrication.



BEFORE YOU MAKE ANY COMMITMENTS –

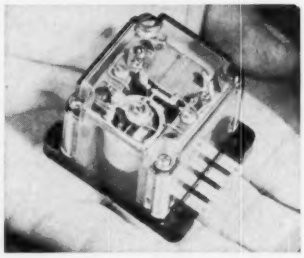
get the facts on Watts new-design units which open up new worlds of efficiency in Pneumatic Operation, Line Maintenance, and Protection of Equipment against foreign matter.

REQUEST CATALOG AND DETAILED SPECIFICATION SHEETS

WATTS REGULATOR COMPANY
SINCE 1875

12 EMBANKMENT ROAD LAWRENCE, MASSACHUSETTS

New Parts



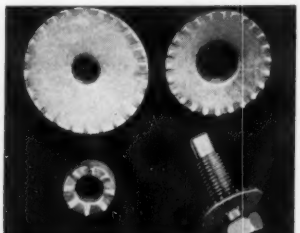
resistance exceeds 1000 megohms. Unit, which incorporates a self-contained reset mechanism, measures approximately 2 x 1¾ x 1½ in. Contacts will not separate even if signal falls, and must be separated by reset mechanism. Relay is available with either single or double limits. Clear-plastic case permits observation of much of the movement. **Assembly Products Inc.,** Wilson Mills Rd., Chesterland, Ohio.

Circle 758 on page 19

Lock Washer

has three-way locking action

Hi-Lock lock washer has barbs on both ID and OD to provide secure locking. Barbs are hardened to enable them to become embedded in mated metal, providing an integral assembly. Unit, which combines flat and lock washer into one,



has vertical, horizontal, and rotary locking. It withstands excessive vibration tests. **Hi-Standard Stamping & Mfg. Co.,** 18228 James Couzens, Detroit 35, Mich.

Circle 759 on page 19

Rotary Air Motors

incorporate single or reversible rotation

Model 6AM reversible rotary air motor is available for use in ½ to 2-hp range. Any four-way operating valve built for pressures below

The new Wooldridge "Cobrahaul" Rear Dump Unit with Fuller 9-speed R-1150 ROADRANGER Transmission.

FULLER R-1150 ROADRANGER® Transmission standard on new Wooldridge "Cobras"!

The Fuller 9-speed R-1150 ROADRANGER Transmission is *standard equipment* in the new Wooldridge 35-ton, 275 hp diesel "Cobrahaul" Dumper and 26-yard 300 hp diesel "Cobra Quad" Scraper. Haul speeds exceed 32 miles an hour on the big 63,400 lb. unit.

Throughout the complete Wooldridge line . . . from the giant 41-yard scrapers down to and including the 7.5-to-10-yard "Cobrette," Fuller Transmissions are standard on Wooldridge Scrapers and hauling units.

Why? Only the most rugged, dependable transmissions can take the terrific shock loads—sudden starts—stops—torque reversals found in all kinds of off-highway operations from solid rock hauling to soggy swamp jobs.

Fuller Transmissions provide maximum ease of shifting ratios for faster acceleration and long life required for these operating conditions.

In Wooldridge's "Cobrahaul" and "Cobra Quad," the Fuller R-1150 ROADRANGER Transmission offers these additional advantages:

- **No gear splitting—9 selective gear ratios evenly and progressively spaced**
- **Easier, quicker shifts—38% steps between ratios**
- **One shift lever controls 9 forward and 1 reverse speeds**
- **Engines work in peak hp range with greater fuel economy**
- **Less driver fatigue—⅓ less shifting**
- **Range shifts pre-selected—automatic and synchronized**

From over 110 models available for rubber-tired equipment, there's a Fuller Transmission designed to do your job.

really ***where horsepower goes to work***

Fuller TRANSMISSIONS

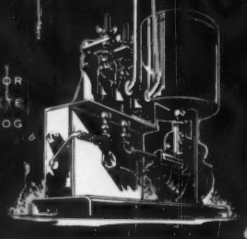
FULLER MANUFACTURING COMPANY (Transmission Division), KALAMAZOO, MICHIGAN

Unit Drop Forge Div., Milwaukee 1, Wis. • Shuler Axle Co., Louisville, Ky. (Subsidiary) • Sales & Service, All Products, West. Dist. Branch, Oakland 6, Cal. and Southwest Dist. Office, Tulsa 3, Okla.

DEPENDABLE,
ACCURATE,
CHEMICAL METERING.

MANZEL CHEMICAL FEEDERS are simple in design, ruggedly built, unfailingly accurate. Fully adjustable for metering any desired amount of liquid from 0 to 1 gallon per minute. Our experienced field engineers are at your service.

WRITE FOR COMPLETE CATALOG



Manzel

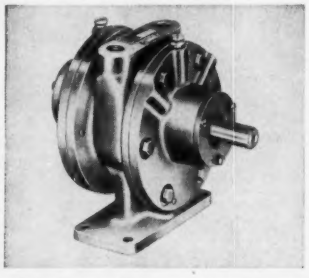
LUBRICATORS • CHEMICAL FEEDERS • SLURRY PUMPS

276 BABCOCK STREET • BUFFALO 10, NEW YORK

A Division of Houdaille Industries, Inc.

New Parts

100 psi can be inserted in air supply line for instantly reversible motor control. Motor ports fit ⅜-in. pipe. Models with single rotation, right or left, have similar dimensions and performance ratings. All motors are explosion-



proof and have variable speeds from 300 to 2000 rpm on air line pressures from 30 to 90 psi. Muffler is included on nonreversible models. **Gast Mfg. Corp.,** Box 117N, Benton Harbor, Mich.

Circle 760 on page 19

Industrial Adhesive

bonds elastomers to textiles

Chemlok 401 bonds Dacron and nylon to uncured natural rubber, GR-S, neoprene, butyl, and Buna N elastomers. It produces a high-strength structural bond, does not degrade the high tensile strength of the fabric in the finished product, and has excellent flex-life characteristics. Room temperature strip adhesion values exceed 100 lb per in., depending upon strength of elastometer compound. Applications include bonding of fabrics to rubber for diaphragms, belting, hose, air springs, and related units. Use of a protective secondary coating maintains adhesive activity during storage. **Lord Mfg. Co.,** Special Products Div., 1635 W. 12th St., Erie, Pa.

Circle 761 on page 19

Rotary Limit Switches

in 250, 500 and 1000:1 units

Additional gear ratios have been added to a line of rotary limit switches. Ratios of 250, 500 and 1000:1 are available in standard fibralloy and cast-aluminum enclosures. NEMA 4, 7 and 12 en-

WHO'S RESPONSIBLE
if the paint finish fails?

No use pointing at one man or one department. When paint finish fails, there's trouble enough for everyone to have a piece of it. Costly rejects and spoilage in the plant; refinishing and reworking charges; lost production; expensive field service to take care of dealer and customer complaints.

Everyone agrees it's best not to have paint finish failures. That's why everyone from the president down so frequently demands Bonderite as the treatment used on metal before painting.

Bonderite is the original corrosion resistant paint base. It creates on metal surfaces an integral coating that's *friendly* to paint, that gives it a firm and lasting anchor. It resists corrosion and multiplies finish durability by three to five times.

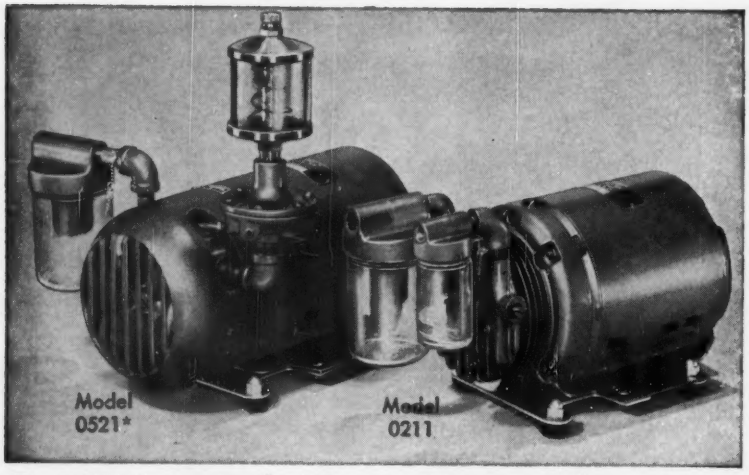
Yes, best guarantee against paint finish failure on metal products is Bonderite. Full information and expert technical assistance is yours for the asking. Write or call today.

Since 1914 — leader in the field

PARKER RUST PROOF COMPANY
2193 E. MILWAUKEE, DETROIT 11, MICHIGAN

BONDERITE	BONDERITE and BONDERLUBE	PARCO COMPOUND	PARCO LUBRITE	TROPICAL
corrosion resistant paint base	aids in cold forming of metals	rust resistant	wear resistant for friction surfaces	heavy duty maintenance paints since 1883

*Bonderite, Bonderlube, Parco, Parco Lubrite, Parker Pre-Namel—Reg. U.S. Pat. Off.



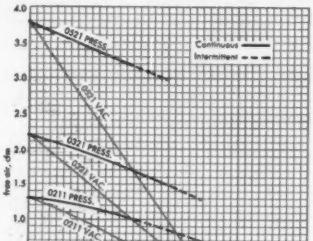
Get 10 Integral-Motor-Pump advantages in two NEW types (three models) of

GAST rotary vane AIR PUMPS

Designers seeking a dependable vacuum or pressure source for industrial instruments, vending machines, air gauge circuits, air sampling, laboratory equipment, printing and packaging machinery, etc., will find these *new* Gast Integral-Motor Air Pumps highly advantageous, especially where compactness and portability count. Consider these outstanding features:

1. Latest type G.E. "Form G" motors.
2. More compact than any pump of equal capacity.
3. Total weight reduced ⅓—cuts shipping costs.
4. Motor mounting time and labor eliminated.
5. Simple, trouble-free rotary-vane design.
6. Vanes take up their own wear automatically.
7. Positive displacement, pulseless air delivery.
8. Improved appearance—smoother exterior.
9. Dependable for original equipment; plant use.
10. Forced air fan cooling on Models 0321 & 0521.

Performance-Vacuum & Pressure



Write for new Bulletins V-356 and P-356!
GAST MANUFACTURING CORP.,
P. O. Box 117-P, Benton Harbor, Mich.

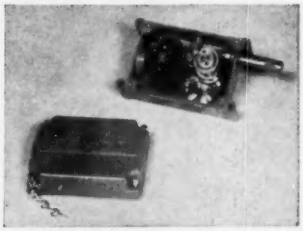
*0321 similar in appearance.

Original Equipment Manufacturers for Over 25 Years

GAST ROTARY
- AIR MOTORS TO 4 H.P.
- COMPRESSORS TO 30 P.S.I.
- VACUUM PUMPS TO 28 IN.

SEE OUR CATALOG IN SWEET'S PRODUCT DESIGN FILE

New Parts



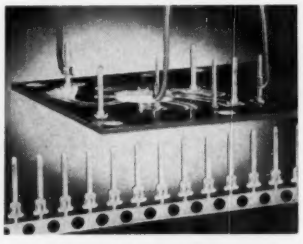
closures are also available. **Gemco Electric Co.,** 25685 W. Eight Mile Rd., Detroit 19, Mich.

Circle 762 on page 19

Wire-Wrap Terminals

for automated printed-circuit assembly

Available in loose or chain form, these terminals incorporate a clinch-type design which holds an individual terminal firmly in the printed-circuit board during additional assembly operations and until permanently soldered. When used in chain form in conjunction with lug inserter, terminals make possible a fully automatic assembly of 20 wire-wrap terminals into



printed-circuit boards, in any pattern, at rates to 20 boards per minute. **Malco Tool & Mfg. Co.,** Dept. MDC, 4025 W. Lake St., Chicago 24, Ill.

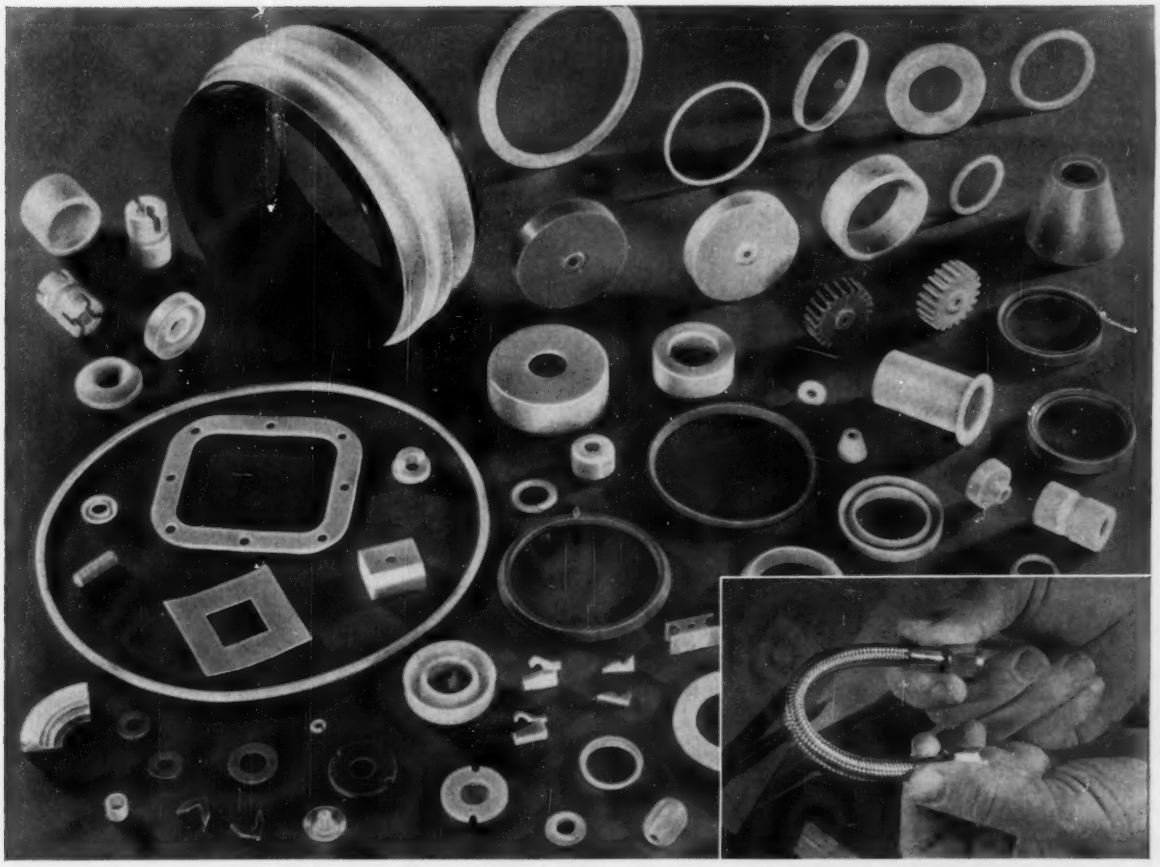
Circle 763 on page 19

Pneumatic Power Unit

for 1000-F actuation

Pneumatic power unit provides a fast-response power source for applications such as thrust reversers, accessory drives, actuation of air inlet and nozzle-positioning systems, and reactor-rod positioning. Unit is adaptable to a wide range of actuation methods. It develops high torque at relatively low speeds, does not disintegrate under overspeed conditions, and operates at 1000 F. High torque-to-inertia ratio allows unit to follow

Circle 530 on page 19



Raybestos-Manhattan has complete facilities for machining parts of "Teflon" such as those shown above. Inset shows R/M Flexible Thin-Wall "Teflon" Hose, which is available with wire-braided or rubber cover, with or without couplings.

Need machined Teflon* components? Let R/M solve your problems and manufacture the parts you need!

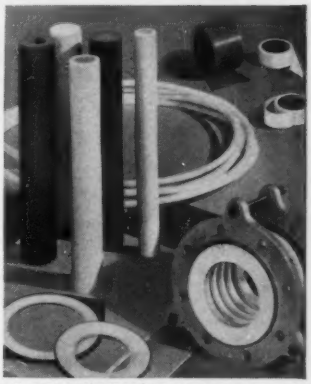
An R/M machined part of "Teflon" may be the answer to your design problem! "Teflon"—versatile, unique wonder plastic—has been tried and found successful in countless applications where no other material could be used.

"Teflon" has properties that no other plastic can match. For instance, nothing will stick to its slippery, waxlike surface. (Unless you specify R/M *bondable* "Teflon"!) No chemicals will react with it. Moving parts made of R/M "Teflon" require little or no lubrication. Temperatures down to near absolute zero or up to 500°F, water, weather, acids, alkalis do not affect it. It is tough and flexible. Its service life is virtually limitless.

R/M has had years of experience in molding, machining and extruding "Teflon." We have a complete line of standard R/M "Teflon" products—and we are fully equipped to manufacture parts of R/M "Teflon" to your specifications. Call on our engineers for assistance with any problem you think "Teflon" might solve—or write for free literature and information today.

Properties of "Teflon": High dielectric strength • Zero moisture absorption • Unaffected by weather • Excellent heat stability up to 500°F in continuous operation • As electrical insulating tape, leaves no carbon residue along discharge path • High impact resistance • Nonadhesive • Stretches easily • Tensile strength 1500-2500 psi

**A Du Pont trademark*



Other R/M "Teflon" Products: rods, sheets, tubes and tape; centerless ground rods held to very close tolerances; stress-relieved molded rods and tubes; gaskets; expansion joints and flexible couplings; bondable "Teflon"; braided metal- and rubber-covered flexible hose; and Raylon (R/M trade name for mechanical grade "Teflon" which has many of the characteristics of virgin "Teflon"). Write for complete data.

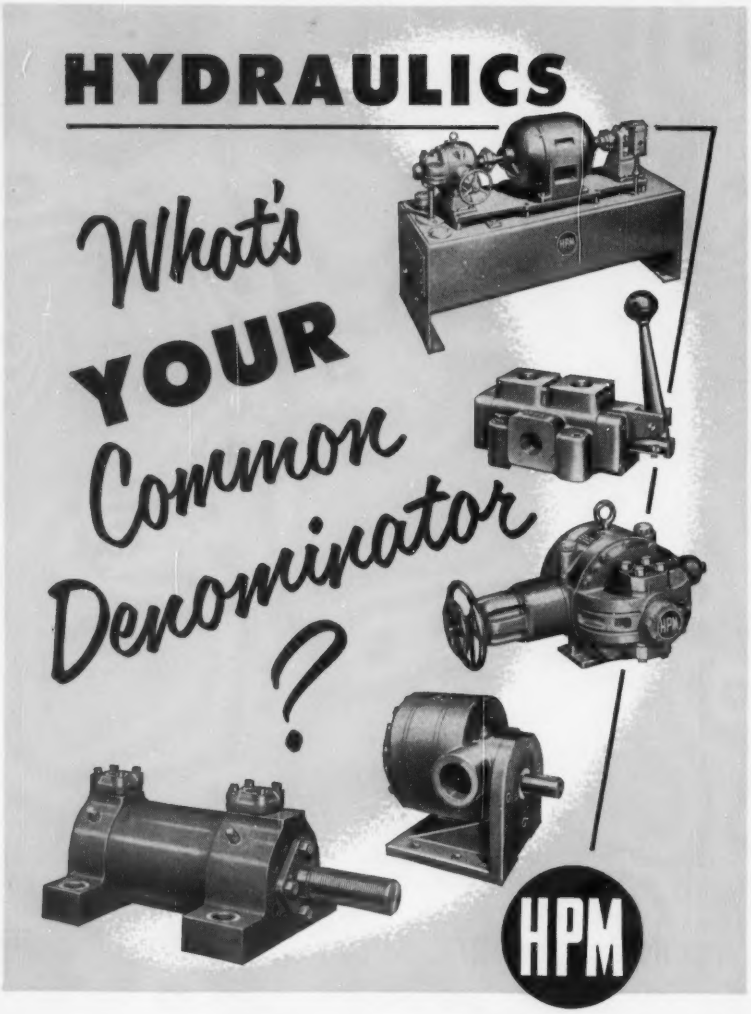
RM

RAYBESTOS-MANHATTAN, INC.

PLASTIC PRODUCTS DIVISION, MANHEIM, PA.

FACTORIES: Manheim, Pa.; Paramount, Calif.; Bridgeport, Conn.; No. Charleston, S.C.; Passaic, N.J.; Neenah, Wis., Crawfordsville, Ind.; Peterborough, Ontario, Canada

RAYBESTOS-MANHATTAN, INC., Engineered Plastics • Asbestos Textiles • Mechanical Packings • Industrial Rubber • Sintered Metal Products • Rubber Covered Equipment Abrasive and Diamond Wheels • Brake Linings • Brake Blocks • Clutch Facings • Laundry Pads and Covers • Industrial Adhesives • Bowling Balls



Selecting the right hydraulic component for each requirement takes years of experience — years of hydraulic system design and application. Picking the right supplier for all your needs is another problem sometimes solved by using more than one source. The common denominator for all your hydraulic problems can be the product line and experience background of H-P-M. A complete line of pumps, power units, valves, cylinders and accessories plus 77 years of hydraulic experience is the answer in most cases. When you're planning hydraulically, call on H-P-M. Write today for Bulletin 1101 — the handy condensed catalog of the complete H-P-M line.

HPM

HYDRAULIC POWER DIVISION

THE HYDRAULIC PRESS MFG. CO.

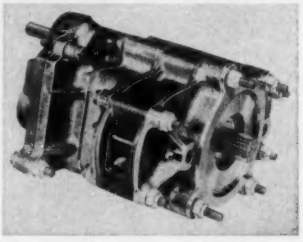
Mount Gilead, Ohio, U.S.A.

A DIVISION OF KOEHRING COMPANY

1877—1957

New Parts

electronic modulation and to deliver instantaneous starts and stops. One model accelerates from 0-100 rpm in 0.00004 sec, operating under 30 psig applied air pressure against opposing force of 20 lb-in. Materials are high-temperature



magnesium alloys, stainless steels and stellites. Unit is available in ratings from 0.66 to 30 hp, operating on pressures from 10 to 300 psig. **Lear Inc.,** 110 Ionia Ave. N. W., Grand Rapids 2, Mich.

Circle 764 on page 19

Stainless-Steel Pumps

have capacities to 200 gpm

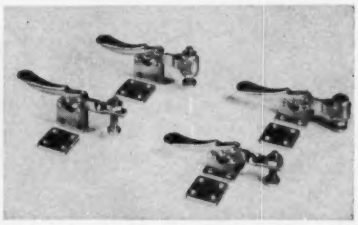
Type 316 stainless-steel construction makes these pumps resistant to many corrosive chemical solutions. All pump parts contacted by liquid are stainless steel, and mechanical shaft seal is Teflon, stainless steel and Remite. Many models have capacities to 200 gpm and heads to 120 ft. Suction and discharge connections range from 1¼ x ¾ in. to 2 x 1½ in. Impellers are dynamically balanced to prevent shaft vibration and to extend seal life. **Bell & Gossett Co.,** 8200 N. Austin Ave., Morton Grove, Ill.

Circle 765 on page 19

Toggle Clamps

small units have holding pressure to 42 lb

Model 105 Tiny Toggles have applications where small clamps with relatively light holding pressures



Vibration won't loosen FLEXLOC self-locking nuts

Where products must be reliable . . . must stand up under vibration, temperature extremes and hard use . . . designers specify rugged, reliable, precision-built FLEXLOC self-locking nuts.

HERE'S WHY:

FLEXLOC locknuts are strong: tensile strengths far exceed accepted standards. They are uniform: carefully manufactured to assure accurate, lasting locking action. And they are reusable: repeated removal and replacement, frequent adjustments, even rough screw threads will not affect their locking life.

Standard FLEXLOC self-locking locknuts are available in a wide range of standard sizes, types and materials to meet the most critical locknut requirements. Your local industrial distributor stocks them. Write us for complete catalog and technical data. Flexloc Locknut Division, STANDARD PRESSED STEEL CO., Jenkintown 18, Pa.

We also manufacture precision titanium fasteners. Write for free booklet. **STANDARD PRESSED STEEL CO.**

FLEXLOC® LOCKNUT DIVISION

SPS JENKINTOWN PENNSYLVANIA

Circle 533 on page 19

FREDDY FEDERAL SAYS:

from prototype to product perfection

SHORT-RUN STAMPINGS may be your answer

- For Cutting Costs
- For Expediting Experimental Work
- For Speeding Pilot Plant Operation
- For Making Quick Product Changes
- For Meeting Time and Cost Budgets
- For Replacement Parts on Obsolete Equipment
- For Small Orders

SAVE UP TO 80%

of the cost of conventional tooling methods with Federal's "Controlled Tolerance" short run stampings. Meet time and cost factors with accurate, quality stampings of any material up to 10"x14"x¼" thick . . . any quantity from 2 pieces to 10,000. Send your print, sketch or part for a Federal Analyzed Quotation. Prompt service and prices.

FREE CATALOG

Tells where and how you can save money using Short Run Stampings. Gives design tips that reduce stamping costs. Write for catalog 201 today.

Federal TOOL & MFG. CO.
3630 Alabama Avenue
Minneapolis 16, Minn.
QUALITY STAMPINGS IN SMALL QUANTITIES

Circle 534 on page 19

New Parts

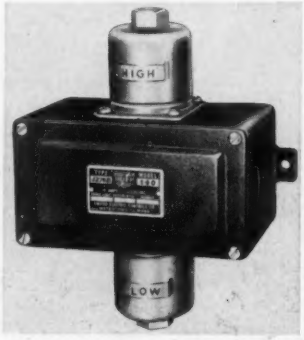
are needed. Only ¾ in. high and 2¾ in. long when closed, clamps have a holding pressure to 42 lb. Four models are available: Two with U-bars and two with solid holding bars. Horizontal and vertical bases are available. Each clamp is equipped with base-spacer mounting plate, 3/32 in. thick, which provides for handling different thicknesses of work pieces or accommodating different mounting positions. **Detroit Stamping Co.,** 338 Midland Ave., Detroit 3, Mich.

Circle 766 on page 19

Pressure Control

is dual-switch differential-control unit

Type J27KB dual-switch differential-pressure unit controls accurately the difference in pressure between two pressure or vacuum



sources. Switches are actuated when pressure on high side exceeds pressure on low side by preset amounts. Seven models offer various system differentials up to 90 psi. Three standard types of switches are available. **United Electric Controls Co.,** 79 School St., Watertown, Mass.

Circle 767 on page 19

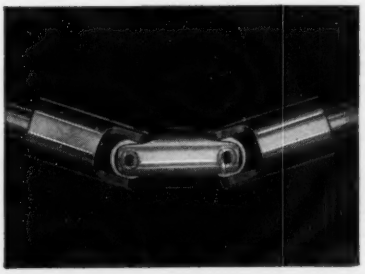
Silicon-Rectifier Stacks

for operating temperatures from −65 to 170 C

Series of silicon-rectifier stacks includes over 200 standard models which are completely preassembled rectifier circuits. Series meets rigid military specifications. Units have applications in computers, magnetic amplifiers, direct-current motor supplies, two-way radio transmitters, and other high-temperature electronic and electrical

How Curtis helped a design engineer "BEAT THE HEAT"

This single universal joint in a ribbon-stripping machine was operated at a 34° angle. The joint heated up, wear was excessive. (Curtis Joints have been tested at angles up to 37°, but we do not ordinarily recommend angles greater than 30°.)



Curtis engineers recommended a *double* Curtis joint, which reduced the angle to 17° per joint. Result: no overheating, improved efficiency, longer life.

You can depend on Curtis engineering in any problem of angular power transmission. And you can depend on

CURTIS UNIVERSAL JOINTS

because our catalog torque and load ratings are substantiated by constant tests under production conditions.

14 SIZES ALWAYS IN STOCK —
⅜" to 4" O.D. (6" joints on special order)

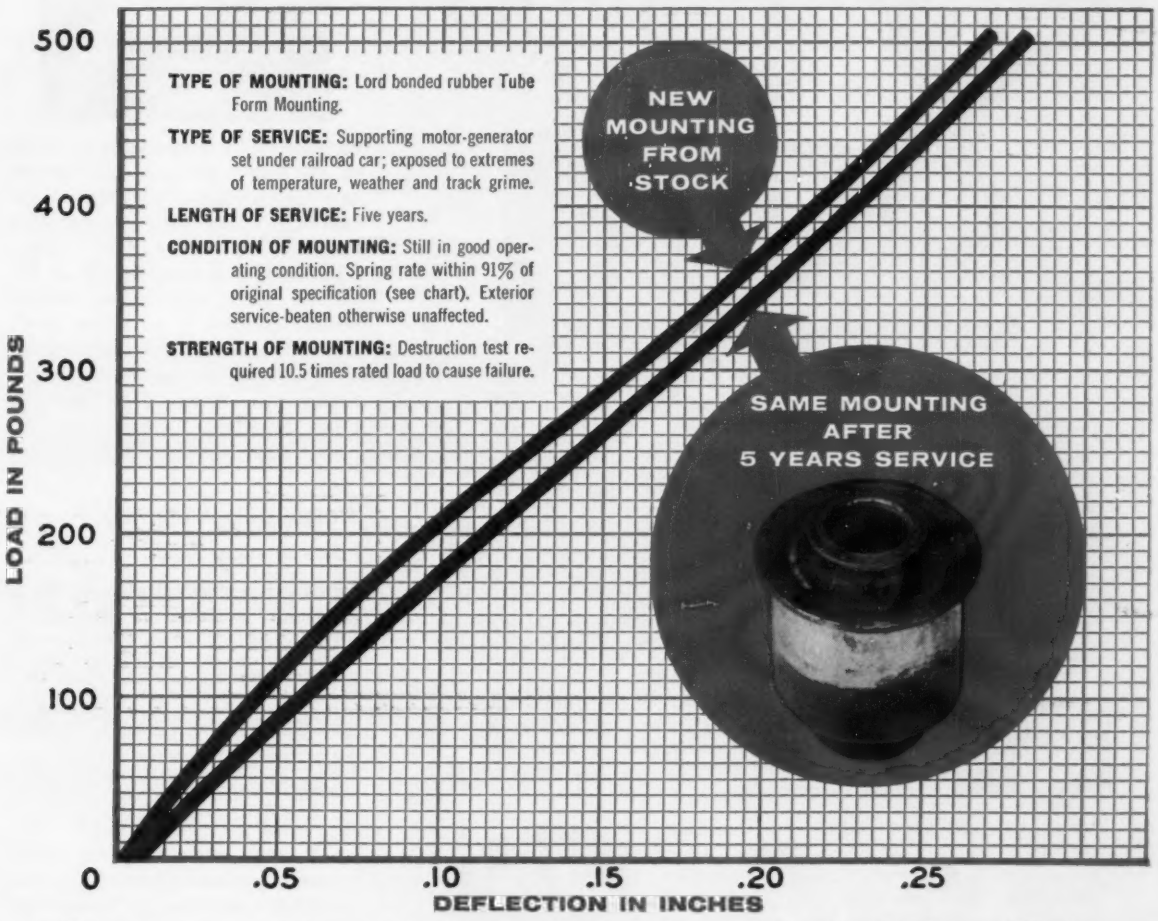
Not sold through distributors. Write direct for free engineering data and price list.

TRADE MARK CURTIS
UNIVERSAL JOINT CO., INC.
5 Birnie Avenue, Springfield, Mass.
As near to you as your telephone

EXCLUSIVELY A MANUFACTURER OF UNIVERSAL JOINTS SINCE 1919

Circle 535 on page 19

what is the life expectancy of a LORD vibration mounting?


500
400
300
200
100
0
LOAD IN POUNDS
.05
.10
.15
.20
.25
DEFLECTION IN INCHES
TYPE OF MOUNTING: Lord bonded rubber Tube Form Mounting.
TYPE OF SERVICE: Supporting motor-generator set under railroad car; exposed to extremes of temperature, weather and track grime.
LENGTH OF SERVICE: Five years.
CONDITION OF MOUNTING: Still in good operating condition. Spring rate within 91% of original specification (see chart). Exterior service-beaten otherwise unaffected.
STRENGTH OF MOUNTING: Destruction test required 10.5 times rated load to cause failure.
NEW MOUNTING FROM STOCK
SAME MOUNTING AFTER 5 YEARS SERVICE

► *five-year service results in little change in isolation efficiency*

How long do LORD bonded rubber mountings retain their excellent vibration isolation characteristics?

Recently, LORD had an opportunity to test a mounting which had been exposed to five years of rigorous service. The remarkable results shown above are a convincing demonstration of the extra-long life of LORD mountings.

This was not an exceptional case, but is typical of the continuous, long-term effectiveness of all LORD products. It is the planned result of (1) the careful design of the contour of the flexing element to provide uniform stress distribution, (2) a rubber-to-metal bond of unsurpassed strength and permanence and (3) elastomers which are specially selected and custom-compounded for each job. And LORD engineers are constantly striving to build even more life into LORD mountings.

The like-new performance of LORD mountings even after long, rugged service means much in terms of lower lifetime costs, fewer mounting replacements, and greater safety.

When you have a problem in vibration control, it makes sense to bring it to LORD—the leader in engineering vibration control and bonded rubber products. Contact your nearest LORD Field engineer or the Home Office, Erie, Pa.

LORD
BONDED RUBBER

designers and producers of bonded rubber products since 1924

LORD MANUFACTURING COMPANY • ERIE, PA.

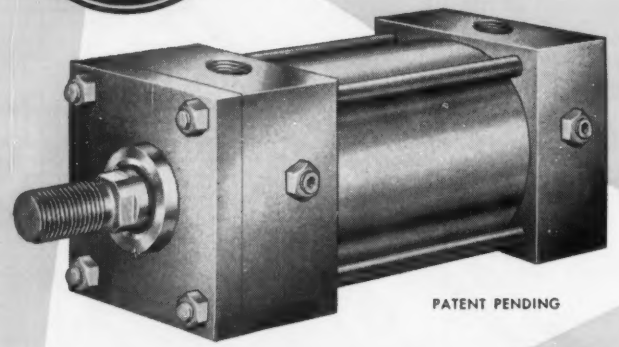
ATLANTA, GEORGIA · CEdar 7-1123
BOSTON, MASS. · HAncock 6-9135
CHICAGO, ILL. · MIchigan 2-6010
CLEVELAND, OHIO · SHadyside 9-3175
DALLAS, TEXAS · RIverside 1-3392
DAYTON, OHIO · MIchigan 8871
DETROIT, MICH. · TRinity 4-2060
LOS ANGELES, CAL. · HOllywood 4-7593
NEW YORK, N. Y. · Circle 7-3326
PHILADELPHIA, PA. · LOcust 4-0147

"In Canada—Railway & Power Engineering Corporation Limited"

Circle 536 on page 19

FOR AUTOMATION

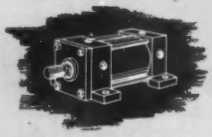
SP CYLINDERS



PATENT PENDING

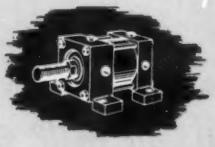
top performance–longest life

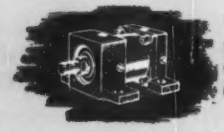
All S-P cylinders are engineered throughout for high speed, efficient operation. Piston rods are heat treated and hard chrome plated to resist scoring. Bronze cartridges with extra long bearing surfaces are easily removable for quick servicing of rod seals and wipers. End plates are rolled steel. All S-P cylinders are built to JIC standards.



S-P STANDARD AIR CYLINDERS have brass tubes to eliminate corrosion. Cushions float on O-rings for maximum cushioning. Eleven bore sizes, 1½" — 14". 21 mounting types. Readily modified for oil or water. Send for Catalog No. 110.

S-P HEAVY DUTY AIR CYLINDERS for automation and other severe applications. Double porting for extreme high speeds. Heavy wall seamless steel tube. Nine bore sizes, 1½" — 8". Five mounting types. Approved and used by two major automobile manufacturers. Send for Catalog No. 109-A.





S-P HIGH PRESSURE HYDRAULIC CYLINDERS have seamless steel tube. Special locking mechanism eliminates tie rods. Designed for 2,000 psi. Eleven models in 11 sizes. Send for Catalog No. 104.

Step up production with S-P cylinders. Representatives in principal cities. Prompt deliveries. Order catalog by number shown above. The S-P Manufacturing Corporation, 30201 Aurora Rd., Solon, Ohio. *In greater Cleveland.*

SPecify SP

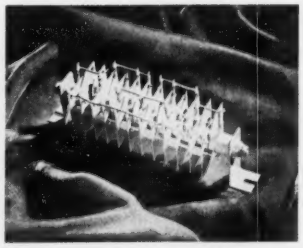
SP THE S-P MANUFACTURING CORP.

SOLON, OHIO • *IN GREATER CLEVELAND*

ESTABLISHED 1916 A BASSETT COMPANY

NON-ROTATING AIR AND HYDRAULIC CYLINDERS • ROTATING AIR AND HYDRAULIC CYLINDERS
POWER CHUCKS • COLLET AND DRILL PRESS CHUCKS • AIR PISTONS, VALVES, ACCESSORIES

New Parts



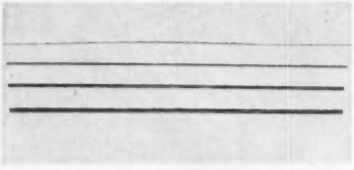
equipment. Rectifiers are rated up to 18 amp per stack, and stacks can be paralleled to obtain high currents. Operating temperature range is from −65 to 170 C. Each rectifier cell is mounted in an all-welded case with glass-to-metal seals. Shown is a 12-fin stack connected in single-phase bridge circuit. **General Electric Co.**, Semiconductor Products, Electronics Park, Syracuse, N. Y.

Circle 768 on page 19

Stainless-Steel Shafting

has 10 micro finish

Type A8 centerless-ground stainless-steel shafting is ground to ±0.0001-in. on diameter and fin-



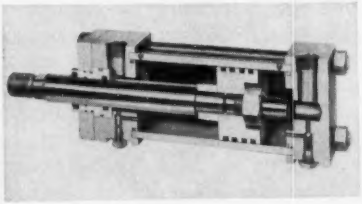
ished to 10 micro finish or better. Diameters from 1/32 to ½-in. are available. **PIC Design Corp.**, 477 Atlantic Ave., East Rockaway, N. Y.

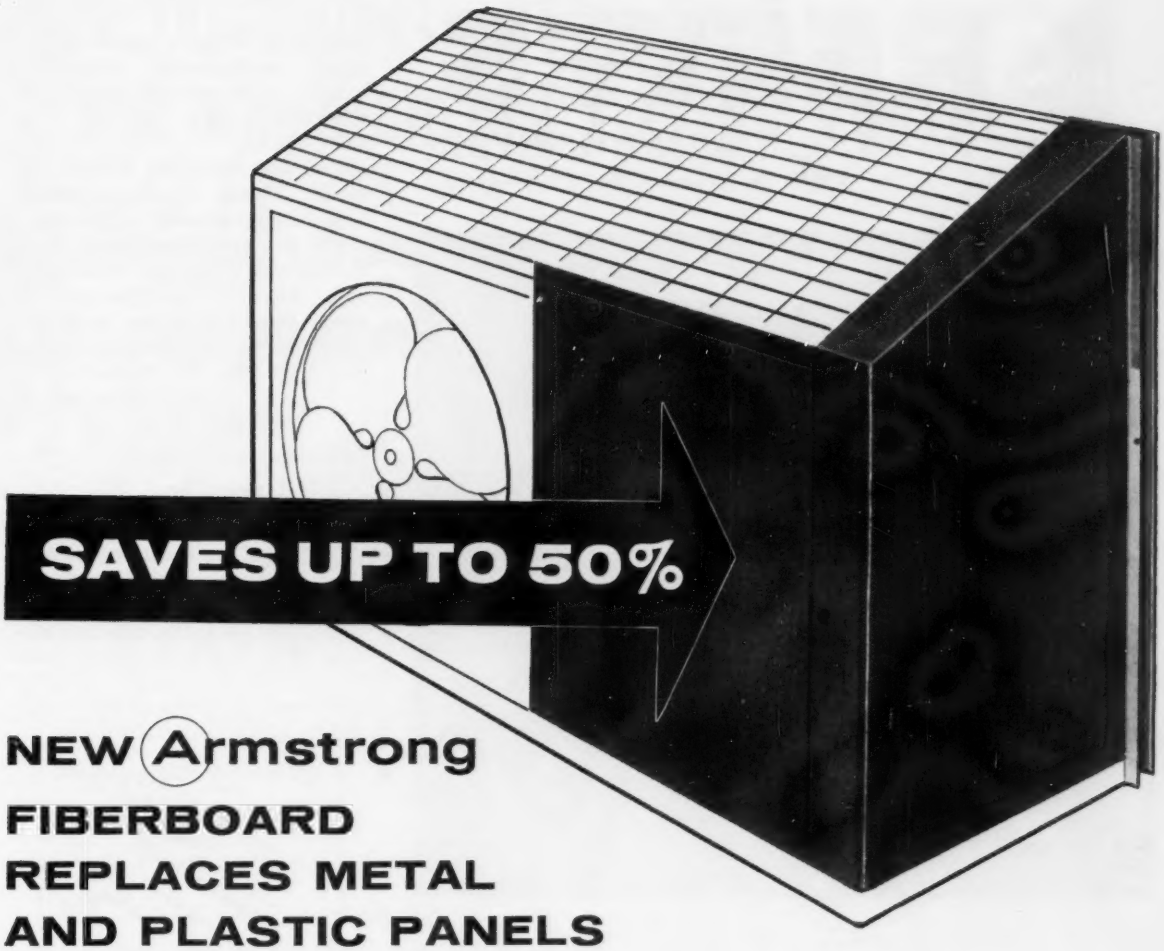
Circle 769 on page 19

Hydraulic Cylinders

for heavy-duty 2000-psi service

Series N hydraulic cylinders are available in bores from 1½ to 12 in. and are rated for operation at 2000 psi and higher. All bore sizes are available in thirteen standard





NEW Armstrong FIBERBOARD REPLACES METAL AND PLASTIC PANELS

Seven leading air-conditioning manufacturers are chopping costs on non-structural panels by substituting new Armstrong Fiberboard for steel and plastic parts. Maybe Fiberboard can save money for you, too.

Here's why Armstrong Fiberboard reduces costs with no sacrifice in product performance:

Costs less/sq. ft. Fiberboard costs under 6¢/sq. ft.; steel for comparable service costs about 19¢/sq. ft.

Easy to fabricate. Inexpensive steel rule dies cut, notch, and punch Armstrong Fiberboard accurately. Scoring permits bending at 90° angle. We supply it in sheets or in parts cut to your specifications.

Lightweight. Weighs about ⅙ as much as comparable steel panels it replaces.

Resists moisture. Special saturant keeps Fiberboard strong, rigid, and dimensionally stable under high humidity, at temperatures up to 175° F.

Odorless. Can't taint food, as in a refrigerator.

Resists fungus attack. Lever Bros. gives Fiberboard a mold growth rating of 000-012. It's the only known material of its kind to pass this test.

Caliper. Standard thickness, .038 inch; also in 2-, 3-, and 4-ply laminations.

See how Fiberboard can cut costs in your product. Mail the coupon today. Armstrong Cork Company, Industrial Division, Lancaster, Penna.

Armstrong FIBERBOARD

Low-cost non-structural panels

Armstrong Cork Company
8609 Dean Street
Lancaster, Pa.

I wish to know more about Fiberboard for possible use in

_____
(kind of application)

- ☐ Have representative call
- ☐ Send samples
- ☐ Send booklet on Fiberboard and other Armstrong felt and fibrous products

Name_____

Title_____

Company_____

Address_____

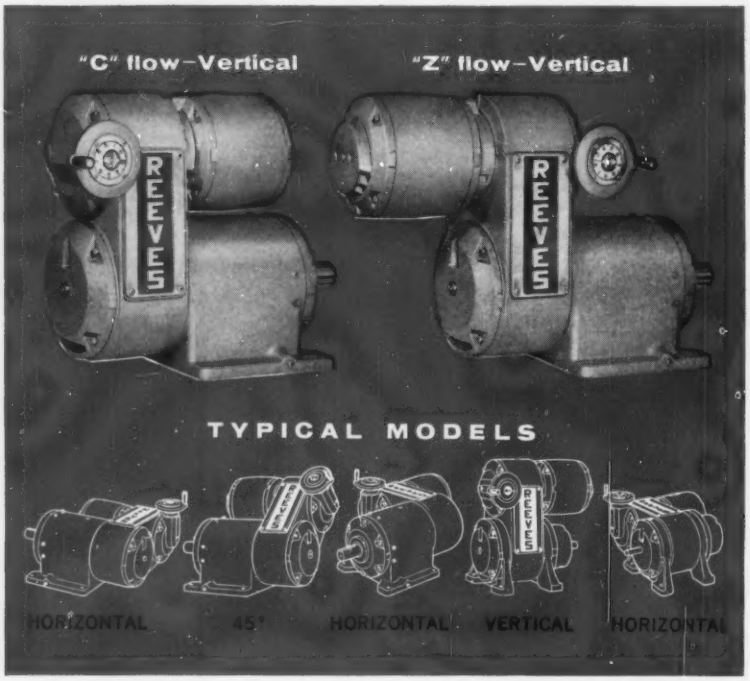
_____

Circle 538 on page 19

NEW **REEVES**®

*Sizes 200-300 Vari-Speed MOTODRIVES**

**200-300 Size, 1 through 5 hp.; full line, ¼ through 40 hp.*



The flexible design of these compact new REEVES variable speed power packages permits hundreds of combinations . . . space-saving, space-fitting *standard* assemblies to meet most installation requirements. All models are available in both "C" flow and "Z" flow styles.

New increased capacity is built in the reducers—single, double or triple stages... new disc assemblies permit wider output speed ranges . . . discs are pre-aligned . . . pre-loaded spring maintains correct belt tension for longer belt wear . . . *exclusive* "close-grooving" lubrication assures free sliding discs . . . new Metermatic system automatically lubricates the motor and variable shaft bearings.

Complete information on all phases of the versatile 200-300 sizes Vari-Speed Motodrives is given in new Catalog. Write for your free copy today—Dept. H32a-M571.

REEVES PULLEY COMPANY

Division of **RELIANCE** ELECTRIC AND ENGINEERING CO.

Columbus, Indiana

Circle 539 on page 19

New Parts

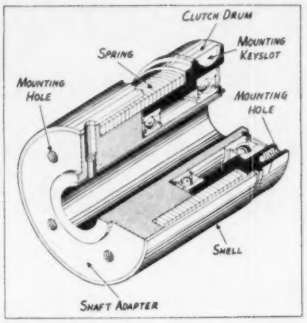
mountings to meet varied installation requirements. Synthetic-rubber wear-compensating rod wiper prevents air and dirt from being sucked into cylinder on in-stroke, and wipes rod dry on out-stroke. Long bronze cartridge-type bearing permits easy maintenance and provides accurate seats for rod-seal wiper and static outer seal. All static seals are standard size O-rings. Cylinders meet JIC specifications. **Hydro-Line Mfg. Co.,** 5600 Pike Rd., Rockford, Ill.

Circle 770 on page 19

Overrunning Clutches

in ball, sleeve, or plain-bearing units

Two lines of standard overrunning Precisionspring clutches are for all overrunning, indexing, and backstopping applications. One line consists of ball-bearing clutches with 20 to 3000 lb-ft torque capacity, other line has sleeve or plain bearings in 8 to 200 lb-in. torque capacity. Driving torque is constant throughout life of clutch, since clutch is self-adjusting. Clutches have high operating speed and are self - energizing. **Curtiss - Wright Corp.,** Marquette Div., 1145 Galewood Drive, Cleveland 10, Ohio.



Circle 771 on page 19

Linear Actuators

utilize standard interchangeable parts

Line of 1080 linear actuators for aircraft needs can be assembled from 64 standard interchangeable parts. Components are grouped into three broad operating capacity classifications: L 12—up to 350 lb; L 16—up to 1500 lb; L 20—up to 3500 lb. All components with-

FROM THESE SIMPLE, BASIC PARTS

ANY COMBINATION FITTING YOU NEED

New IDEAL SIMPLET UNIVERSAL FITTING

open-face bodies and hub-covers—easily assembled in seconds

- RUGGED, DURABLE MALLEABLE IRON
- MEET J.I.C. AND N.M.T.B.A. STANDARDS
- HUBS REVISED WITHOUT REPLACING FITTING
- LARGER WIRING AREA
- COVERS SUPPLY HUBS FOR CONDUIT — NO NEED TO DRILL
- PRECISION TAPERED PIPE THREADS
- MOUNTING LUGS, CONDUIT STOPS
- LIQUID, DUST, LINT PROOF

Ideal-Simplet introduces this revolutionary advance in conduit fitting design with the *new* Universal Fitting. It provides an almost infinite variety of hub combinations for practically any wiring job!

With only *five* basic body sizes and a wide choice of covers, every practical style and type of fitting with multiple hubs can be assembled in a matter of seconds. Your fittings inventory and overall costs can be substantially reduced. Standards, "specials" and even seldom-used styles are available immediately from stock!

It would pay you to get the facts about this new Ideal-Simplet Universal Fitting, NOW!

SEE YOUR WHOLESALER . . . or send coupon →

Pioneers in conduit fittings and electrical specialties

IDEAL

SIMPLET FITTINGS, Inc.
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1059-I Park Avenue • Sycamore, Illinois

IDEAL-SIMPLET FITTINGS, Inc.
1059-I Park Avenue, Sycamore, Ill. IDEAL

Send Universal Fitting data

Name_____

Company_____

Address_____

City_____ Zone____ State_____

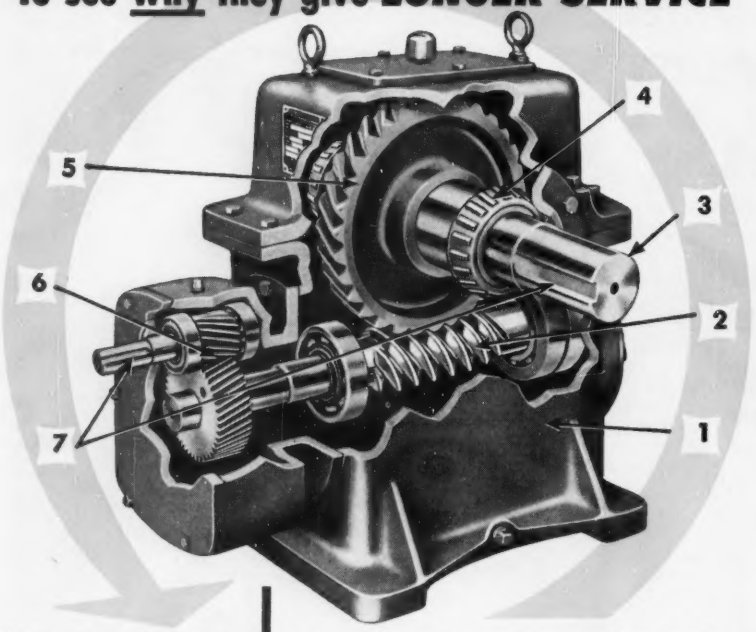
Wholesaler's Name_____

Circle 540 on page 19

Look Inside a Foote Bros.

ENCLOSED WORM GEAR DRIVE

to see why they give LONGER SERVICE



1 EXTRA STRONG CAST HOUSING
Provides rigid mounting and alignment of caps and bearings. Made of high quality cast iron.

2 PRECISION ALLOY STEEL WORM
Integral with oversize shaft. Carefully matched to worm gear for quiet, trouble-free service.

3 OVERSIZE OUTPUT SHAFT

4 HEAVY DUTY, EXTRA LARGE BEARINGS
Oversize bearings used throughout unit. Worm bearings are combination single row radial and angular contact ball bearings. Input shaft bearings are single row radial type.

5 WORM GEAR
Precision generated from uniform density, high hardness virgin bronze alloy casting. High load carrying capacity.

6 HEAT TREATED HELICAL GEARS
Shaved for full tooth contact. Pinion integral with input shaft. Gear locked in position on worm shaft extension.

7 Just one of 10 different types, in a wide range of sizes, ratios and shaft arrangements.

One look at the oversize bearings, larger shafts, precision made gearing and the sturdy housing of a Foote Bros. Hygrade Worm Gear Drive tells you that *this* is a workhorse unit that will stand up and deliver under the toughest conditions.

Notice the carefully balanced design . . . greater mass where it's needed . . . the elimination of weight when it contributes nothing to efficiency . . . strength and toughness at the right places . . . the correct gear alloys . . . the compact design, and above all, the simplicity and ruggedness of this unit.

When you know the *inside* story of Foote Bros. Hygrade Worm Gear Drives, you can understand why they have built a reputation for quality, dependability, and performance that is unmatched by others.

Call in a Foote Bros. Field Engineer. Take advantage of our long experience in this business. Let us help you select or specify the most economical drive for your application.

Write for Engineering Manual HGB. It contains complete information on Hygrade Enclosed Worm Gear Drives.

this trademark stands for the finest industrial gearing made

FOOTE BROS. Dust-Rated LIFETIME BEARING

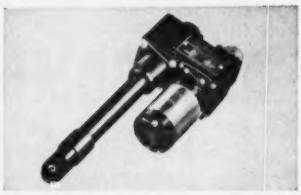
T. M. REG. U. S. PAT OFF

FOOTE BROS.

Better Power Transmission Through Better Gears

FOOTE BROS. GEAR AND MACHINE CORPORATION
4567 South Western Boulevard Chicago 9, Illinois

New Parts



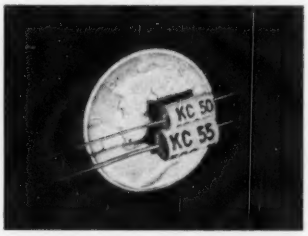
in each classification are interchangeable, and some are interchangeable between classifications. Actuators consist of motor, gear reducers, limit switches, accessory drive or transmitter, and screw jack. Line meets MIL-A-8064A general military specification for linear actuators. **Airborne Accessories Corp.,** 1414 Chestnut St., Hillside 5, N. J.

Circle 772 on page 19

Carbon Film Resistors

exceed requirements of MIL-R-105909B

Carbon film resistors are for use in circuits requiring maximum stability and small size. Seven sizes are available with ratings from 1/10 to 2 w. Seals are machine-soldered to provide maximum uniformity. Resistors exceed requirements of



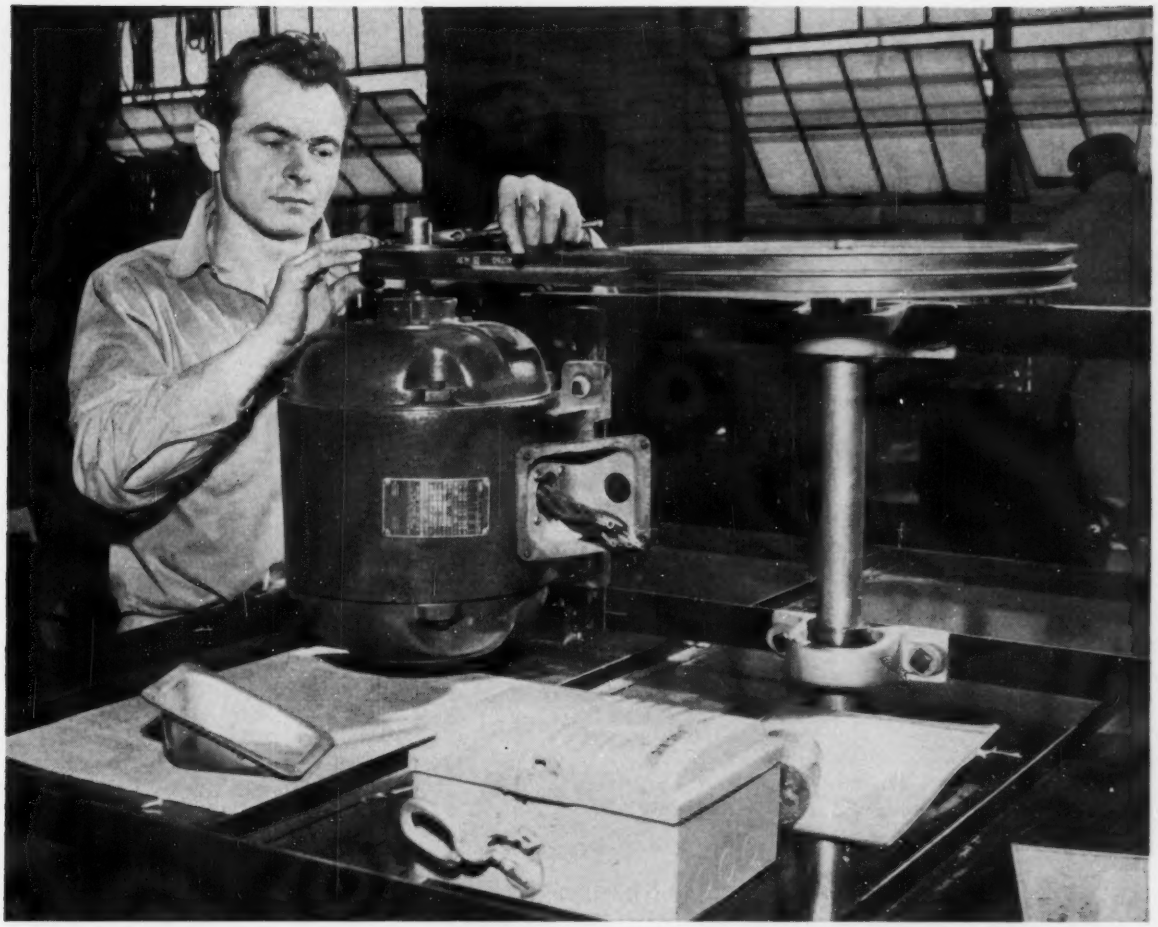
MIL-R-105909B, Characteristic B. **Key Resistor Corp.,** 321 W. Redondo Beach Blvd., Gardena, Calif.

Circle 773 on page 19

Panel Clip

attaches panel sections on any metal cabinet

Dart-type Speed Clip, developed to attach panel sections on any type of metal cabinet, is adaptable to appliances, radio and television sets, shelving, metal cabinets or any panel - to - panel application where removability is a factor. A reusable unit, the clip has resilient spring tension in each of its legs which combats vibration and allows for slight misalignment of



AT PENN VENTILATOR COMPANY

DIEHL motors increase product dependability

Operating dependability is an inherent feature of the power-roof ventilators made by Penn Ventilator Company, Philadelphia, Pa. Usually, these ventilating units are installed in locations completely exposed to the elements and relatively inaccessible for regular servicing. Failure in operation, however, could halt an important manufacturing operation or even cause complete plant shut-down. Hence, every detail in the design and construction of Penn Ventilators is considered with a view to the assurance of uninterrupted operation for long periods of time with a minimum of maintenance.

This is one of the reasons why Penn Ventilator Company has consistently selected DIEHL motors for its equipment. James T. Ellington, Penn Director of Purchases says: "We can't gamble with an inferior unit—a reliable motor is a necessity! DIEHL motors are trouble-free and well suited to all our requirements."

Here is another example of how DIEHL has cooperated with a progressive manufacturer to build a product of highest quality and proved reliability. With almost three quarters of a century of experience in the design and manufacture of motors, DIEHL is well equipped to help you solve your motor problems. We'll work closely with you to provide the right motor —at the right time—at the right price.

DIEHL MANUFACTURING COMPANY
Electrical Division of
THE SINGER MANUFACTURING COMPANY
Finderne Plant, SOMERVILLE, N. J.

Diehl

☐ Please send me Consolidated Motor Catalog and Price List No. MD-9 3540

☐ Please have a DIEHL representative call

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Superior Powder Metallurgy often makes possible tremendous savings. Parts virtually impossible with other materials are easy with this method. Note the other advantages listed above and then... tell us what your job or problem is, preferably via blue print or drawing. Perhaps we can cut *your* costs in half, too.

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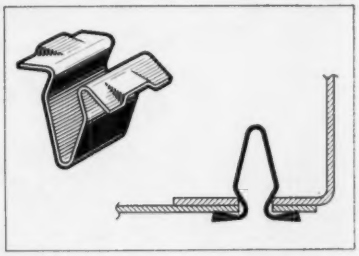
SCP
SUPERIOR CARBON BRUSHES
"Since 1919"

Circle 543 on page 19

New Parts



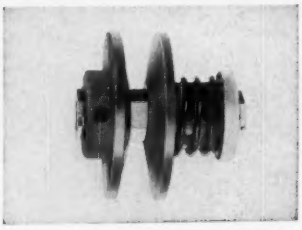
clearance holes. Outward thrust of legs and downward thrust of embossed feet work together in a clamping action, sandwiching two panels together. **Tinnerman Products Inc.**, P. O. Box 6688, Cleveland 1, Ohio.

Circle 774 on page 19

Adjustable-Speed Pulley

molded plastic unit has extreme chemical resistance

Model VP-1 pulley provides adjustable-speed operation for fractional-horsepower ¼-in. V-belt drives. Molded of impregnated nylon glass fiber, pulley is self-lubricating, has extreme chemical resistance, and excellent long-wearing qualities. Unit measures 1⅞ in. OD with maximum 1⅝ in. pitch diameter. Shaft bores of ¼,



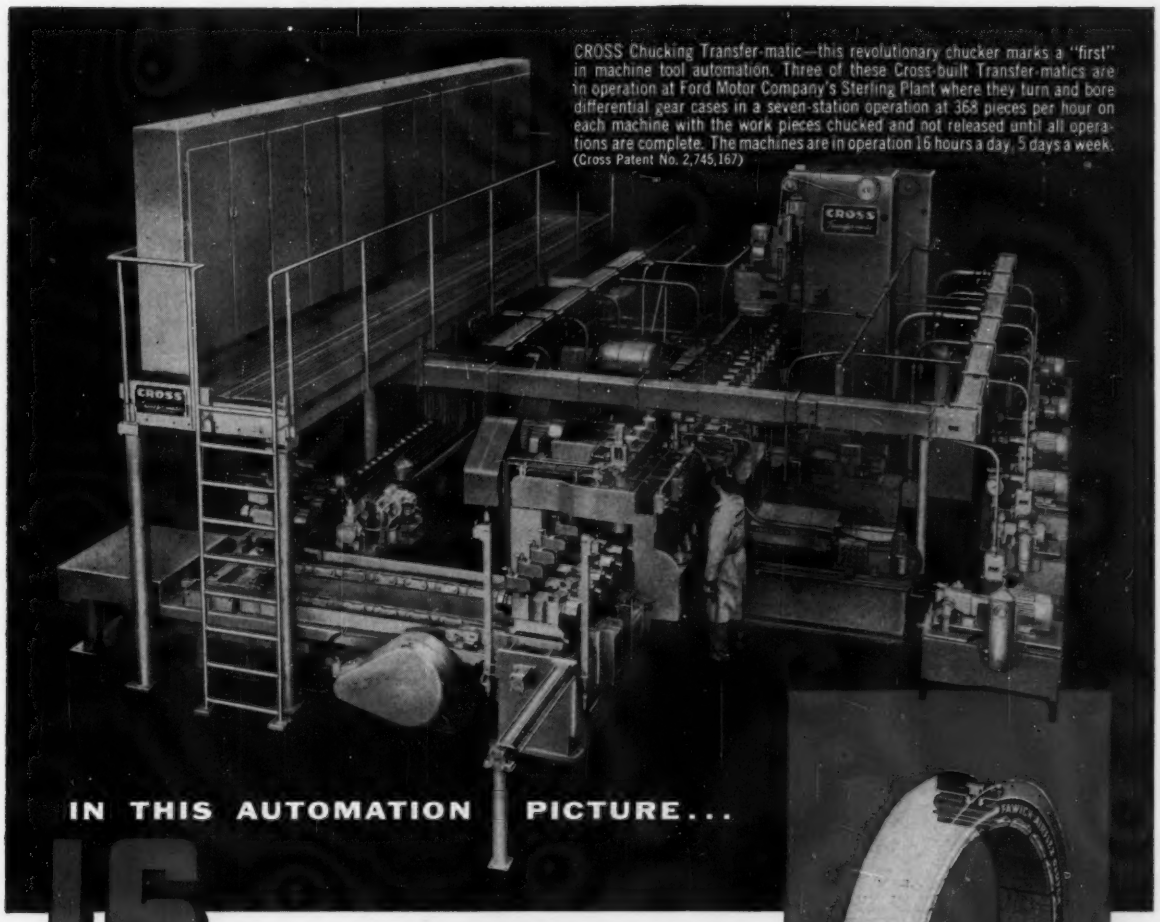
5/16, and ⅜ in. are available. Uses include drive mechanisms for instruments and servo systems, business machines, and aircraft devices. **Rampe Mfg. Co.**, 14915 Woodworth Ave., Cleveland 10, Ohio.

Circle 775 on page 19

Ceramic Fiber

withstands temperatures of over 2000 F

Fiberfrax ceramic fiber, an aluminum silicate material, is available as roving, yarn, cord, rope, woven tape, broadwoven fabrics, and other textile forms. Weights range from 15 to 74 oz per sq yd,



CROSS Chucking Transfer-matic—this revolutionary chucker marks a "first" in machine tool automation. Three of these Cross-built Transfer-matics are in operation at Ford Motor Company's Sterling Plant where they turn and bore differential gear cases in a seven-station operation at 368 pieces per hour on each machine with the work pieces chucked and not released until all operations are complete. The machines are in operation 16 hours a day, 5 days a week. (Cross Patent No. 2,745,167)

IN THIS AUTOMATION PICTURE...

16 Fawick Clutches *making power behave*

CB *Airflex* Clutch: For high speed cyclic or continuous operation . . . needs no lubrication . . . adjusts automatically for wear of friction shoes.

FAWICK Clutches are vital components of these machines. A total of 16 model CB Airflex units provide the critical power control necessary to the precision automatic operation of each Chucking Transfer-matic. Here is what FAWICK Airflex Clutches offer:

- **instant response**
- **lifetime "new-clutch" action**
- **full-power transmission**
- **greater safety**
- **freedom from maintenance**

FAWICK Clutches are used in these and many other automatic machines because of their outstanding performance—proof again of FAWICK leadership in *making power behave!* Discover the outstanding advantages of FAWICK power control products *today*. Call or write the home office or your nearby FAWICK representative.

FAWICK AIRFLEX DIVISION
FAWICK CORPORATION
9919 Clinton Road • Cleveland 11, Ohio
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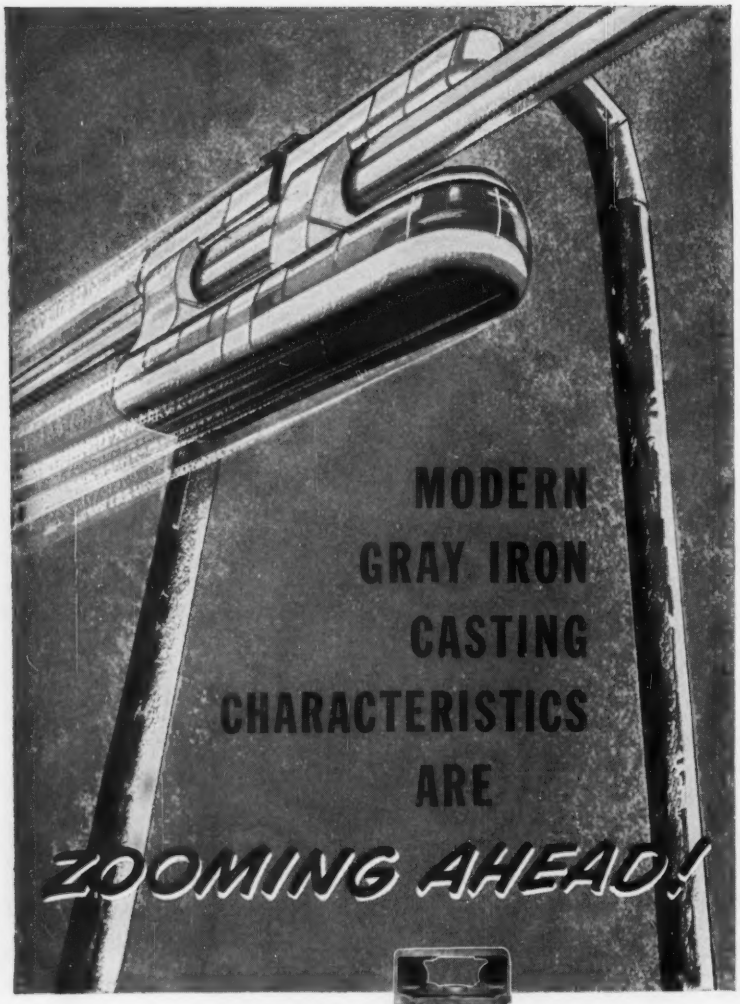
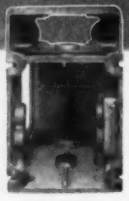
FAWICK *Airflex*
INDUSTRIAL CLUTCHES AND BRAKES

Circle 544 on page 19





This Gray Iron machine base saved 50% over fabricated steel design. It also improved the appearance and added desired performance factors.

With today's new ductile irons, users are buying iron castings under standard specifications with strengths more than 100,000 p.s.i.! Gray iron parts are also being used in structural applications under loads at temperatures up to 800°F. Learn how to make lower-cost products by utilizing the improved mechanical and physical properties of gray iron castings . . . *the most economical of all component parts.* Have at your fingertips the new Gray Iron Founders' Society Summary of Specifications, giving the latest properties of ductile and standard gray irons.

Free Summary of Specifications. Be sure you are fully acquainted with the new characteristics of gray iron. Ask your foundryman or write for a copy of GIFS up-to-date "Summary of Specifications".

it's time to design with

GRAY IRON CASTINGS

GRAY IRON FOUNDERS' SOCIETY, INC.
National City-East 6th Bldg. • Cleveland 14, Ohio

Circle 545 on page 19

New Parts

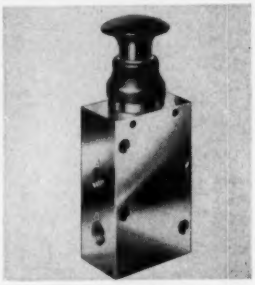
and fabrics are made from staple fiber yarns in a variety of weaves and constructions. Low thermal conductivity, high yarn bulk, natural resilience and small fiber diameter provide excellent insulating properties. Material withstands temperatures in excess of 2000 F. Uses include insulating blankets and wrappings, gaskets, filter media, protective clothing, conveyor belts, heat and flame barriers and membranes, and other high - temperature applications. **Carborundum Co.,** Niagara Falls, N. Y.

Circle 776 on page 19

Pilot Valve

has protective rubber boot

Flo-Pilot valve incorporates a small, synthetic-rubber boot which snaps in place around valve stem, sealing critical parts from dirt and abrasives. Aluminum, stainless



steel and molded nylon are used to provide resistance to corrosion. Five interchangeable actuating heads are available: Palm button, ball cam, lever, locking lever, and mechanical link clevis. Valve can be base, panel, or wall mounted, and can be used as either a two or three-way unit. It is for 150-psi air operation and has ¼-in. pipe ports. **Hanna Engineering Works,** 1765 Elston Ave., Chicago 22, Ill.

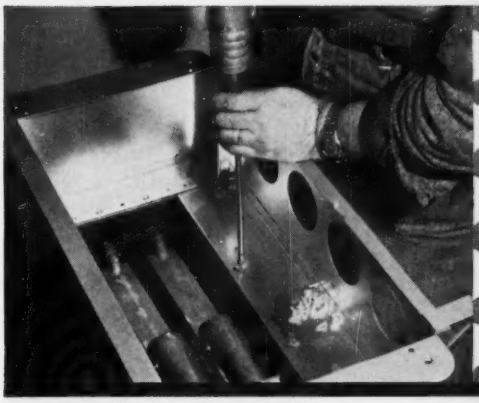
Circle 777 on page 19

Illuminated Meters

have lamps screwed into front of meter cases

Six-volt illumination is available with black plastic, 4½-in. rectangular contact meter-relays, panel meters, and pyrometers. Two 3-v, 0.19-amp aviation lamps, connected in series, are screwed into

Investigate the assembly savings made possible by P-K® self-tapping screws



Because P-K Type A Self-tapping Screws have clean, deep slots and sharp gimlet points . . . and because they are consistently uniform, Reznor Mfg. Co. enjoys important savings in the assembly of their gas heaters.

To hold the plastic handle halves of their Instant Heat Soldering Irons together, The Lenk Mfg. Co. specifies P-K Type F Self-tapping Screws. No need for a separate tapping operation. Production is increased and costs reduced—thanks to P-K Screws.

Melnor Industries, Inc. (formerly Melnor Metal Products Co.) puts assembly strength into their famous "Swingin' Spray" oscillating lawn sprinkler by fastening zinc and aluminum parts with P-K Self-tapping Screws—7 Phillips Head Type Z and 18 Type F. They start right . . . drive right . . . and stay tight.

PARKER-KALON DIVISION, General American Transportation Corporation
Manufacturers of Self-tapping Screws, Socket Screws, Screwnails, Masonry Nails, Wing Nuts and Thumb Screws

PARKER-KALON® fasteners

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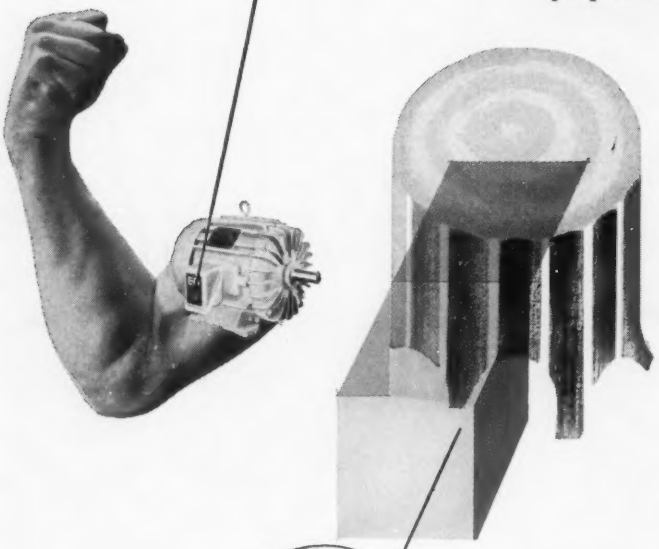
Circle 546 on page 19

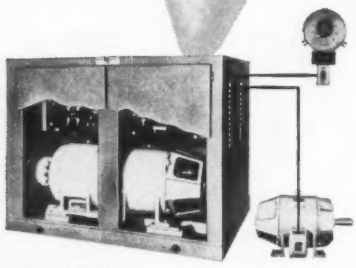
The mark of an Extra Dependable machine

POWER
for the
paper industry



It takes rugged power to move the tons of pulp and water in a converter . . . to move the rollers of a Fourdrinier . . . the kind of *power* that Electro Dynamic *standard* and *special* motors furnish paper processing machinery.

The red E. D. "power spot" is your assurance of *extra dependable* Electro Dynamic power . . . over 75 years in developing . . . yours today *at no extra cost!*

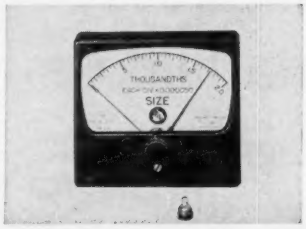


30 h.p. SELECTROL
VARIABLE-SPEED DRIVES

ELECTRO DYNAMIC
DIVISION OF GENERAL DYNAMICS
CORPORATION

BAYONNE, NEW JERSEY

New Parts



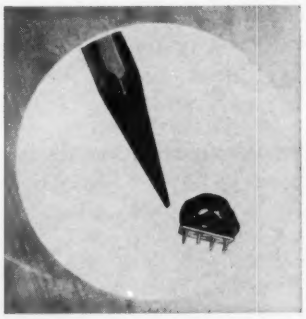
the meter cases from the front. Screw-in feature results in dust-tight lamp installation. Life of lamps ranges from approximately 350 hr at full voltage to more than 12,000 hr at 2.25 v. **Assembly Products Inc.**, Wilson Mills Rd., Chesterland, Ohio.

Circle 778 on page 19

Miniature Transformer

for printed-circuit applications

Epoxy-encapsulated plug-in unit provides high moisture resistance and is insulated for high operating temperatures. Plug-in terminals are spaced on multiples of 0.1-in. for standard grids. Transformer is for use in printed-circuit appli-



cations where small space and low weight are necessary. **Celco Constantine Engineering Laboratories Co.**, Island Ave., Mahwah 1, N. J.

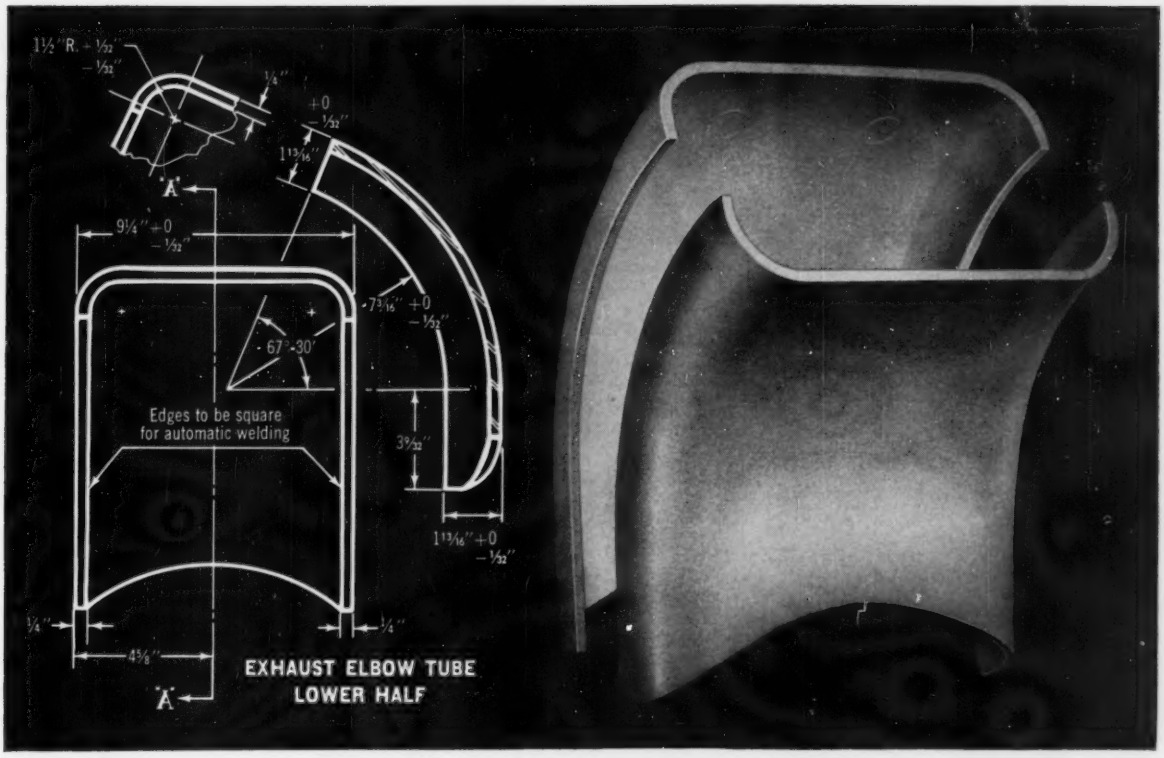
Circle 779 on page 19

Corrosionproof Pipe

for fluids and gases is Teflon lined

Fluoroflex-T-S corrosionproof pipe with fittings is lined with high-density Teflon compound which is chemically inert at temperatures to 500 F. Pipe handles all hot acids, including hydrofluoric and aqua regia, and caustics in applications where high temperatures

Circle 547 on page 19



Stamping tolerances held +0 -1/32" solve tough design problem

Previous attempts to fabricate diesel locomotive exhaust elbows by stamping had proved unsatisfactory. Tolerances necessary for production welding of the parts could not be held. Too many bad welds resulted and rejects piled up. Forging the part from hot rolled seamless tubing likewise proved too expensive.

Commercial engineers proved the elbows could be turned out as stampings and now Commercial is producing them from 1/4-inch flat steel with accurate tolerances of +0 −1/32.

These close tolerances are important because the two halves of the elbow are welded together automatically. If the opening between the parts is too wide, the weld metal will not bridge the opening. If it is too narrow, the metal will not penetrate the joint properly.

The accuracy of the Commercial dies also assures exact fit of both the square end of the tube, which is welded to the engine block opening, and the curved end, which is welded to a cylindrical manifold. No trimming of these ends is necessary.

The end result is consistently strong even welds at all points, few rejects, faster assembly. By switching from hot rolled tubing at 15 cents a pound to mild flat steel at 6 cents a pound, a substantial cost saving was also effected.

Custom stamping to very close tolerances of even very large or complex parts has long been standard operating procedure at Commercial.

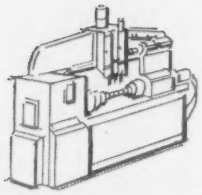
We invite you to submit your blueprint, sketch, or sample for study. Commercial engineers can advise you without obligation on ways and means to improve the component parts. Very often slight design modification makes possible the use of Commercial's "die-bank" of over 2300 basic die components, resulting in substantial savings in the overall cost of the part.

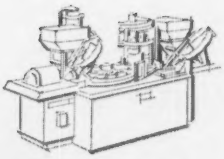
Address inquiries or requests for forming engineering assistance to The Commercial Shearing and Stamping Company, Dept. S-38, Youngstown 1, Ohio.

SPECIALISTS IN CUSTOM FORMING THROUGH STAMPING • UPSET FORGING • HYDROSPINNING

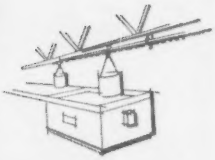
COMMERCIAL shearing and stamping

Circle 548 on page 19

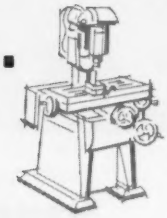


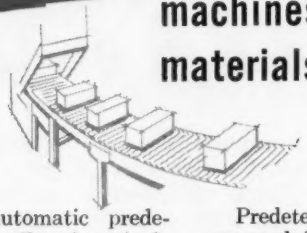


NEW ELECTRIC PREDETERMINING COUNTER...



for remote operation of machines, processes, materials handling





This Veeder-Root automatic predetermining control device offers, in a single unit, new convenience and flexibility in the solution of machine and process control and materials handling problems. Five readily set control knobs provide great ease in establishing any of the 100,000 possible control points. The electromagnetic counting unit permits the use of a wide variety of remote actuators, switches, contactors, electric eyes, or other sensing units. This provision, in conjunction with the several possible electrical control circuits, allows completely remote operation of the controlled equipment.

Predetermining control units can be grouped in a single central location for convenient setting of the predetermined quantities and visual monitoring of the accumulated counts. Additional ease of operation is afforded by the two-second duration electric reset which allows completely automatic recycling, automatic reset in preparation for the following cycle, or push button reset whenever desired. For full details, write:

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Everyone can count on

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and/or pressures accelerate corrosion. Covered with seamless-steel pipe with 150-lb flanges threaded and welded at each end, pipe liner is formed over full gasket face of

flanges so that it becomes an integral one-piece gasket and liner. Assemblies are available in five sizes from 1 to 4 in. Elbows are also available with the same liner. **Resistoflex Corp.**, Woodland Rd., Roseland, N. J.

Circle 780 on page 19

Subminiature Switch

is high-performance unit

Type 16 subminiature switch incorporates new switch mechanism, using stainless-steel springs, which provides long mechanical life. Light weight and short contact blades provide excellent vibration and shock resistance. Double-end plunger bearing permits operation directly from cams. High overtravel and positive stop also pro-

vide operation without actuators. Switch, rated 10 amp, 30 v dc inductive or 115 v ac, is for aircraft safety applications. **Illinois Tool Works,** Licon Switch Div., 2501 N. Keeler Ave., Chicago 39, Ill.

Circle 781 on page 19

Lock Nut

has 360-deg locking action

Reverse-Lok one-piece all-metal lock nut is a reversible and reusable unit. Uniform locking torque and multiple re-use are provided by 360-deg locking action. Nut is available in steel, brass, aluminum and stainless, in a wide

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Circle 550 on page 19

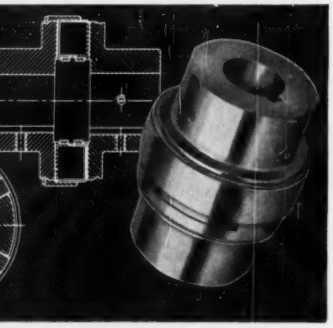
LOVEJOY

Power Transmission Equipment

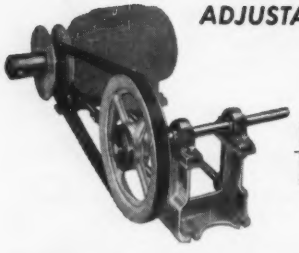
Job-Rated for the Particular Load to Give Maximum Performance on Your Job

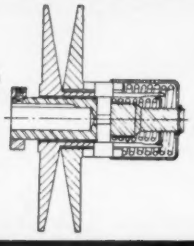
NON-LUBRICATED
EASILY-ASSEMBLED
FLEXIBLE COUPLINGS

Bores (max.).....⅜" to 9½"
O.D. .....⅝" to 21½"
Wt. .....½ oz. to 1500 lb.
H.P. .....1/20 to 3000
Torque (static)..1½ to 5100 ft.-lbs.



MAINTENANCE-FREE INSTANTLY-ADJUSTABLE VARIABLE SPEED PULLEYS

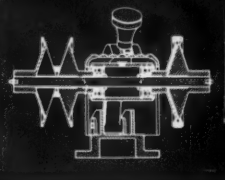


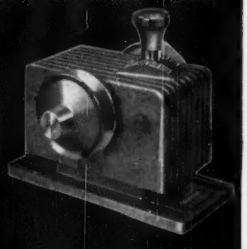


Bores (max.).....½" to 1⅜"
O.D. .....3" to 13⅜"
Belt Sizes.....A to 2¾ TW
Speed Ratios.....1-1 to 8-1
H.P. (1750 rpm.)....¼ to 15

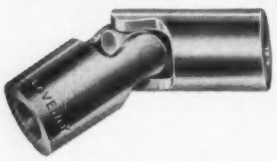
ECONOMICALLY-PRICED INFINITELY-VARIABLE SELECT-O-SPEED TRANSMISSIONS

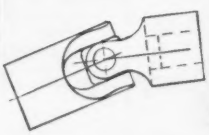
Controls . Lever or Hand Wheel
Belt Sizes.....A to C
Speed Ratios.....1-1 to 10-1
H.P. (1750 rpm.)...½ to 7½





LIGHT-WEIGHT PRECISION-BUILT UNIVERSAL JOINTS





Bores.....¼" to 2"
Hub Dia. .....½" to 4"
Static Torque 340 to 130700 in.-lbs.
H.P. (100 rpm.).....½ to 207

Get Lovejoy performance for your equipment.
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LOVEJOY FLEXIBLE COUPLING CO.

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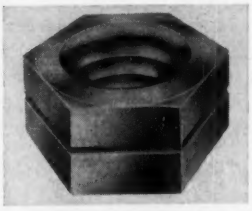
New Parts



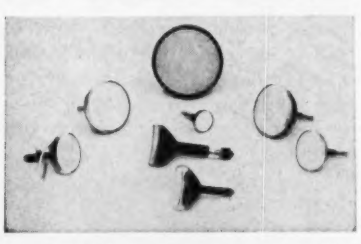
range of standard sizes. **Jacobson Nut Mfg. Corp.**, Box 177, Kenilworth, N. J.

Circle 782 on page 19

Radar Tubes

are short-neck units for miniaturization use

Designed to meet requirements of miniaturization techniques in airborne, marine, and portable radar receivers, these radar tubes are short-neck units which reduce space requirements by as much as 6 in. They are available in electrostatic and magnetic-focus types with diameters from 3 to 10 in. Typical operating voltages are from 7 to 18 kv. All units have a ⅞-in. neck diameter, miniature nine-pin base, and feature magnetic deflection. Standard or



aluminized screens are available. Photo foreground shows new short-neck unit compared with its standard counterpart. **Allen B. DuMont Laboratories Inc.**, 750 Bloomfield Ave., Clifton, N. J.

Circle 783 on page 19

Hydraulic Drive

has wide speed and power range

Type W drive incorporates full-throated construction to provide compactness and high capacities. Flexible in application, the drive can be used with seal or stuffing box, glass or stainless-steel reactors. It has a high range of power and agitator speed. Standard 2.5, 3, 4 and 5W drives are

BEFORE YOU SAY

"IT CAN'T BE CAST"

Transmission Shifter Fork

Automatic Winch Brake Pawl Carrier

CALL AN ESCO ENGINEER

ESCO alloy steel castings can make your designing *easier*. You get the part you want, in the alloy you need and in the shape that saves you the most fabricating, machining and finishing time.

PLUS METALLURGICAL ENGINEERING AND RESEARCH
ESCO maintains one of the largest and best equipped metallurgical staffs of any alloy steel foundry—

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We're fully equipped to handle your largest requirements, as well as smaller production-run sizes. Shell mold, cast-to-size, centrifugal casting are also right down our alley.

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NATIONAL BEARING DIVISION

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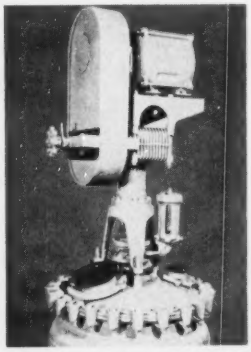
equipped with constant-speed sheaves and static-free belts which combine to give any required speed. Variable sheaves with static-free belts give greater agitator speed.



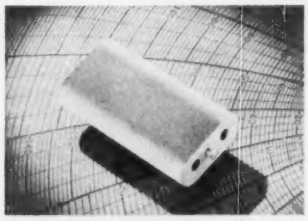
Drive is available with double-reduction gearing and flange-mounted motor to provide gear drive for agitator speeds from 525 to 7.3 rpm in 27 increments. **Pfaudler Co.**, 1045 West Ave., Rochester, N. Y.

Circle 784 on page 19

Electronic Connectors

for aircraft use in pitot-tube assembly

High - temperature, high - altitude connectors are for use in aircraft pitot-tube heater assemblies. Body is of mica to withstand continuous temperatures to 850 F or intermittent temperatures to 1000 F. Beryllium-copper contacts are spaced to



permit use at altitudes of 70,000 ft. **H. H. Buggie Inc.**, Box 817, Toledo 1, Ohio.

Circle 785 on page 19

Constant-Speed Drive

is mechanical unit for aircraft alternators

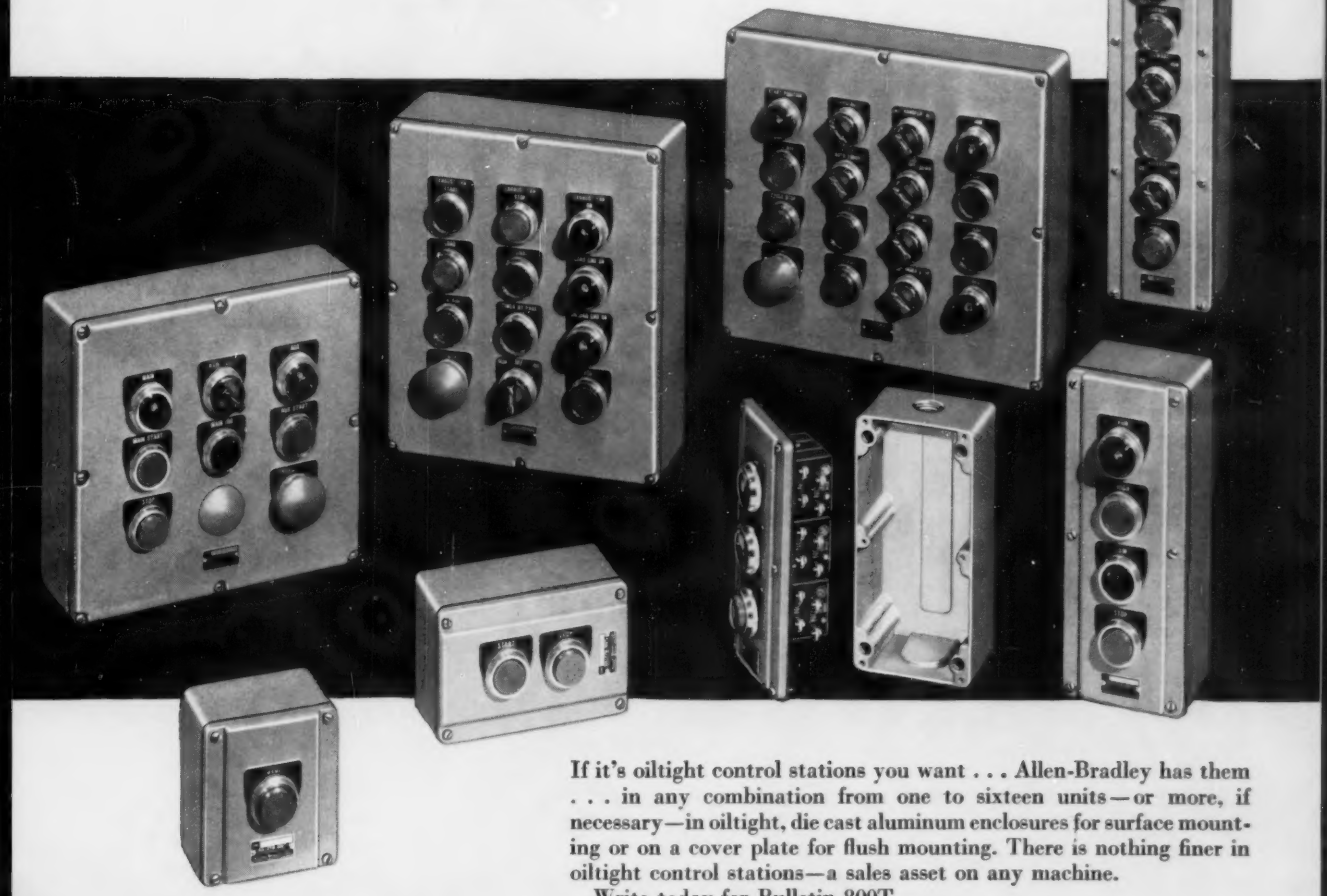
Mechanical constant-output-speed drive maintains ac-generator speed constant in 400-cycle aircraft installations regardless of variation

Circle 553 on page 19

Circle 554 on page 19→

NOTHING FINER IN oiltight control stations

BULLETIN 800T

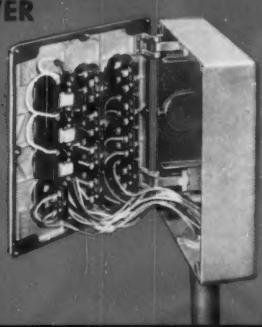


If it's oiltight control stations you want . . . Allen-Bradley has them . . . in any combination from one to sixteen units—or more, if necessary—in oiltight, die cast aluminum enclosures for surface mounting or on a cover plate for flush mounting. There is nothing finer in oiltight control stations—a sales asset on any machine.

Write today for Bulletin 800T.

HINGED COVER

The 9, 12, and 16-unit control stations have hinged covers. The hinge can easily be changed in the field from one side to the other.



ALLEN-BRADLEY
MOTOR CONTROL
QUALITY

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

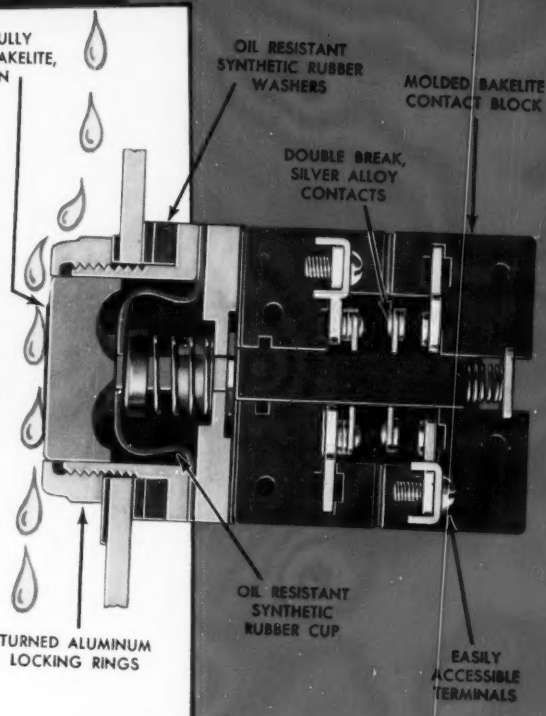
10-57-RM

for machine tool application . . .

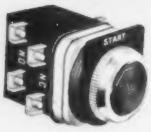
BULLETIN 800T oiltight control units

These rugged, reliable units were designed as pilot controls for a-c and d-c magnetic motor control. The oil resistant synthetic rubber cup and washers keep cutting fluids and oil away from the contacts, and thus prevent trouble. Push button units can be furnished with one, two, or four contact blocks—each equivalent to a separate single pole, double throw, switch unit.

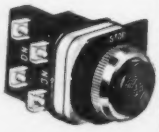
For attractive appearance plus long life with reliable operation, select Allen-Bradley control units.


LARGE, FULLY GUARDED, BAKELITE, BUTTON
OIL RESISTANT SYNTHETIC RUBBER WASHERS
MOLDED BAKELITE CONTACT BLOCK
DOUBLE BREAK, SILVER ALLOY CONTACTS
OIL RESISTANT SYNTHETIC RUBBER CUP
TURNED ALUMINUM LOCKING RINGS
EASILY ACCESSIBLE TERMINALS

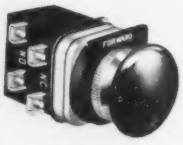
PUSH BUTTONS



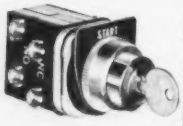
Flush Head Start" Button



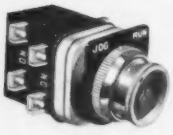
Extended Head "Stop" Button



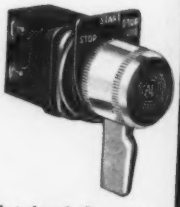
Mushroom Head for Easy Operation



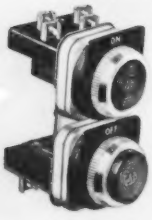
Push Button with Cylinder Lock



Push Button with "Selector" Sleeve



Wing Lever Push Button

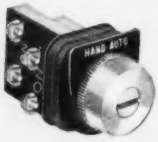


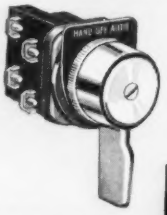
Maintained Contact Push Buttons

SELECTOR SWITCHES

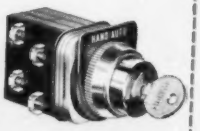
Three-Position Selector Switch

Two-Position Coin Slot Selector Switch





Wing Lever Selector Switch

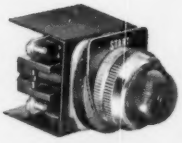


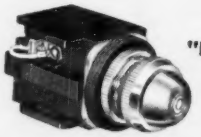
Selector Switch with Cylinder Lock

PILOT LIGHTS

Transformer Type Pilot Light

Full Voltage Pilot Light





"Press-to-Test" Pilot Light

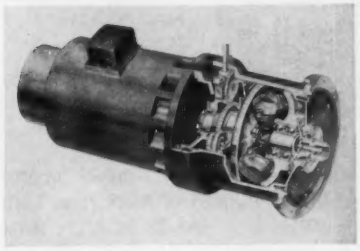
A-B QUALITY

ALLEN-BRADLEY MOTOR CONTROL QUALITY

Allen-Bradley Co.
1316 S. Second St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

10-57-RM

in input speed or electrical load. Unit also has applications in marine, automotive, and industrial fields. The 20-kva unit operates in ambient intermittent temperature to 365 F. Unit permits automatic paralleling of two or more gener-



ators and automatic protection against system failures. Input speed range is 2300-8500 rpm; output speeds are 6000, 8000, or 12,000 rpm. **Avco Mfg. Corp.,** Lycoming Div., Stratford, Conn.

Circle 786 on page 19

Synchro Clamps

are quick-release units for frame sizes No. 10-19

Synclamp component clamps have a molded-in nylon insert with threads cut by the screw. Clamp turns with screw, providing locknut effect. When clamp is stopped by shoulder, nylon insert permits

screw to continue turning until clamp is properly seated. Clamps are 18-8 stainless steel, fit frame sizes 10 through 19, and meet applicable shock, vibration and environmental tests. **Timber-Top Inc.,** P. O. Box 14, Freeport, N. Y.

Circle 787 on page 19

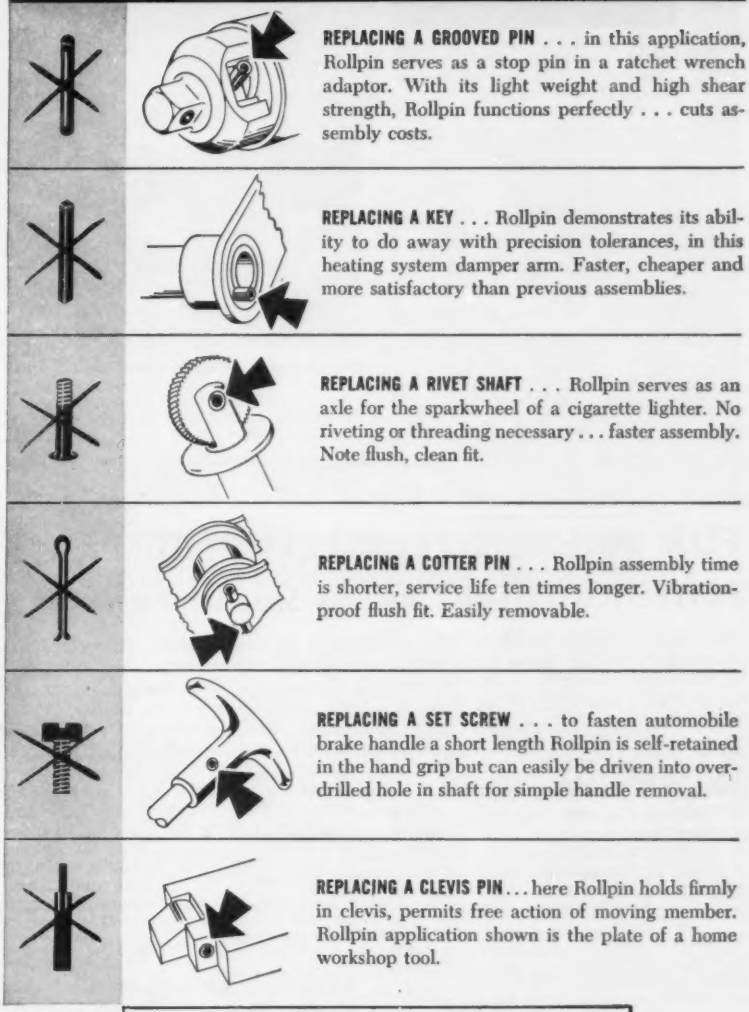
Motor-Generator Set

in 500, 1000, 1500, and 2000-w models

Four models of 400-cps motor-generator sets are available in 500,

FASTENER PROBLEM

6 ways Rollpin simplifies fastening operations



REPLACING A GROOVED PIN . . . in this application, Rollpin serves as a stop pin in a ratchet wrench adaptor. With its light weight and high shear strength, Rollpin functions perfectly . . . cuts assembly costs.

REPLACING A KEY . . . Rollpin demonstrates its ability to do away with precision tolerances, in this heating system damper arm. Faster, cheaper and more satisfactory than previous assemblies.

REPLACING A RIVET SHAFT . . . Rollpin serves as an axle for the sparkwheel of a cigarette lighter. No riveting or threading necessary . . . faster assembly. Note flush, clean fit.

REPLACING A COTTER PIN . . . Rollpin assembly time is shorter, service life ten times longer. Vibration-proof flush fit. Easily removable.

REPLACING A SET SCREW . . . to fasten automobile brake handle a short length Rollpin is self-retained in the hand grip but can easily be driven into over-drilled hole in shaft for simple handle removal.

REPLACING A CLEVIS PIN . . . here Rollpin holds firmly in clevis, permits free action of moving member. Rollpin application shown is the plate of a home workshop tool.

WHERE CAN YOU USE THIS SIMPLE FASTENER?

Rollpin is the slotted tubular steel pin with chamfered ends that is cutting production and maintenance costs in every class of industry.

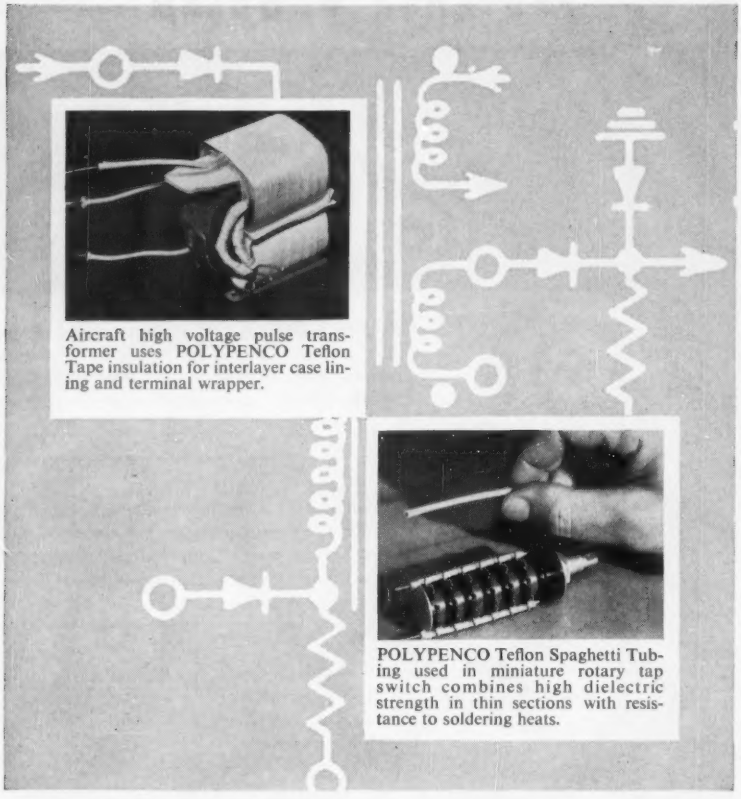
Drives easily into standard holes, compressing as driven. Spring action locks it in place—regardless of impact loading, stress reversals or severe vibration. Rollpin is readily removable and can be re-used in the same hole. Made in carbon steel, stainless steel and beryllium copper. Write for samples and information, ELASTIC STOP NUT CORPORATION OF AMERICA, 2330 Vauxhall Road, Dept. R49-94, Union, New Jersey.

ELASTIC STOP NUT CORPORATION OF AMERICA

Vauxhall Road, Dept. R49-94, Union, New Jersey.

ROLLPIN®

Circle 555 on page 19



Aircraft high voltage pulse transformer uses POLYPENCO Teflon Tape insulation for interlayer case lining and terminal wrapper.

POLYPENCO Teflon Spaghetti Tubing used in miniature rotary tap switch combines high dielectric strength in thin sections with resistance to soldering heats.

FOR MINIATURE ELECTRONIC PARTS

POLYPENCO TEFLON* Assures Superior Performance

With increased emphasis on the miniaturization of electronic systems, Teflon tape and spaghetti tubing are being subjected to more severe requirements than ever before. Uniform density and controlled properties in thin-walled sections are of major importance. That's why POLYPENCO Teflon is being used so widely in the electronics field today. Polymer's rigid in-process testing assures you unvarying quality . . . the quality necessary to design and fabricate more minute parts and components for top performance.

Teflon's Outstanding Properties

- Dielectric Constant.....2.0
- Power Factor.....0.0005
- Dissipation Factor.....0.0002
- Dielectric Strength, Volts/mil..400-500
- Volume Resistivity.....1015 ohm-cm
- Surface Resistivity 100% R.H.....1013 ohm
- Water absorption.....Zero
- Fungus Resistance.....Excellent
- Services entire frequency range
- Arc Resistance—Good, leaves no carbon path regardless of time of exposure

Stock Shapes Readily Available

POLYPENCO Teflon rod, tubing and sheets are available in a wide range of sizes. POLYPENCO Teflon Tape and Spaghetti Tubing are made in 10 fade-proof colors for coding. Spaghetti Tubing is available in 26 AWG sizes from No. 30 to 0. Nationwide stocking and service points assure prompt delivery. The name of your nearest representative is immediately available on request.

Fabricating Service

Custom fabricated parts are available from The Polymer Corporation of Penna., engineered for the best in design, quality and tolerance.

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THE POLYMER CORPORATION OF PENNA.

Reading, Pa.

Export: Polypenco, Inc., Reading, Pa., U.S.A.

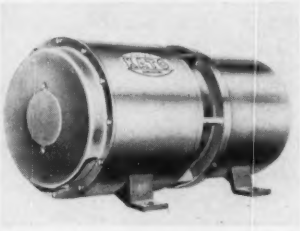
*DU PONT TRADEMARK

POLYPENCO

POLYPENCO nylon, POLYPENCO Teflon*, FERROTRON® and NYLATRON® GS

New Parts

1000, 1500, and 2000-w sizes. Illustrated is a 200-w model. Alternator is of the inductor type with 115 v, single-phase output. Ca-



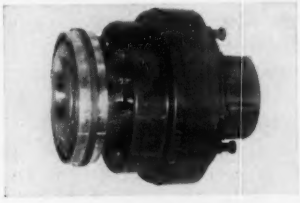
pacity-start 4-hp drive motor maintains speed of 3428 rpm. Unit is 25 in. long and 13 in. high. **Kato Engineering Co.**, Mankato, Minn.

Circle 788 on page 19

Clutch Couplings

transmit high torques without slippage

Originally designed for use in steel, aluminum, and other mills, this clutch-coupling line has been broadened to include higher and lower ratings than previously offered, and to meet a wider range of applications. Clutch coupling is a heavy-duty, low-inertia, posi-



tive-engagement unit utilizing serrated teeth for transmitting high torques without slippage. Design provides lower moment of inertia than friction-type couplings. Ratings range from 1200 through 32,000 lb-ft torque. **Dings Brakes Inc.**, 4740 W. Electric Ave., Milwaukee 46, Wis.

Circle 789 on page 19

Multipurpose Latch

is lightweight unit of aluminum alloy

This latch, designated 27L, is composed of handle and adjustable fork. Unit acts as handle, ejector, pull and lock. Made of aluminum alloy, latch accommodates a minimum panel size of 5 in. A 6-lb

Can You Call a Man a "Failure" at Thirty?

Men who think that success is only a matter of "a few years" are failures . . . however young they are!

How often have you heard some young man in business say, "I'll admit the job I have now isn't much but, after all, I'm only in my twenties."

Or: "Just about every executive in the company I work for is between 45 and 65. I have plenty of time to get ahead."

This *mistaken* idea that success comes automatically with time is easy to understand. Promotions do come regularly and effortlessly to young men of promise. *But* the day arrives, often abruptly, when that promise must be *fulfilled*. Native ability and intelligence can carry a man only to the mid-way point in business—beyond that he must *prove* his capacity to justify a position of executive responsibility. That calls for a practical, working knowledge of business fundamentals.

The time to build that knowledge—to lay a solid groundwork for your future progress—is now . . . *now* while time is still on your side. If you fail to recognize that fact, you'll know only struggling, skimping and regret when your earning power should be at its height.

FOR THE BUSINESS MAN WHO REFUSES TO STAGNATE

HALF the world is half asleep! Men who could be making twice their present salaries are coasting along, hoping for promotions but doing nothing to bring themselves forcefully to the attention of management. They're wasting the most fruitful years of their business lives... throwing away thousands of dollars they'll never be able to make up.

If *you* want to discover how to start to succeed while you're still young—if you want to avoid the heartbreak of failure in later years—send today for "Forging Ahead in Business"... one of the most practical and helpful booklets ever written on the problems of personal advancement. You will discover what the qualifications of an executive are in today's competitive market... what you must know to make $15,000, $20,000 or more a year... what you must *do* to accumulate this knowledge.

"Forging Ahead in Business" was written for ambitious men who seriously want to get down to bed-rock in their thinking about their business future; there's no charge for the booklet because, frankly, we've never been able to set a price on it that would reflect its true value. Some men have found a fortune in its pages. If you feel that it's meant for you, simply fill out and return this coupon. Your complimentary copy will be mailed to you promptly.

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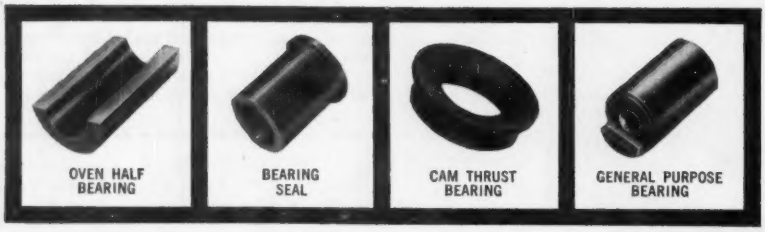
- ARE NON-CONTAMINATING
- FUNCTION IN HIGH TEMPERATURES
- OFFER IMMUNITY TO CORROSION

Morganite Bearings with "built-in" lubrication offer a dependable solution to lubrication problems in aircraft fuel pumps and meters. In boiler, furnace or oven equipment they operate at full efficiency in high temperatures. They are ideal for sealed mechanisms or where inaccessibility makes ordinary methods of lubrication impractical. Morganite is non-corrosive, functions smoothly and efficiently when immersed in water, acids or alkalies.

Simplify Design with Morganite — Self-lubricating valves, slides, seal noses, rotary vanes, gland and piston rings, pump vanes and other parts are available to specifications. Write to Morganite for engineering data and recommendations on your particular requirements.



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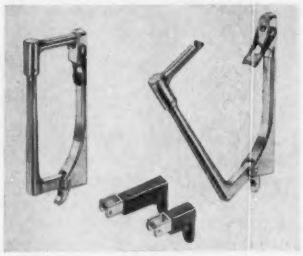
Manufacturers of Fine Carbon Graphite Products including Carbon Specialties, Motor and Generator Brushes, Carbon Piles, Current Collectors and Electrical Contacts
Distributors of 99.7% Pure Al_2O_3 Tubes and Crucibles

Circle 558 on page 19

New Parts

maximum load disengages handle lock; maximum horizontal working load is 400 lb, ultimate load, 600 lb. Designed for use on electronic chassis, unit can also be



used on radio racks, bowling alley equipment, aircraft ground handling equipment, and food processing machinery. **Camloc Fastener Corp.,** 22 Spring Valley Rd., Paramus, N. J.

Circle 790 on page 19

Heavy-Duty Switch

handles up to 2 hp

Duo-Snap heavy-duty, snap-action switch is available in four different terminal and circuit arrangements which permit at least six circuit

variations. Snap action is achieved through rolling spring principle. Ratings are: 2 hp, 230 v ac; 1 hp, 150 v ac; and for pilot duty, 20 amp, 250 v ac. **Robertshaw-Fulton Controls Co.,** Acro Div., Columbus, Ohio.

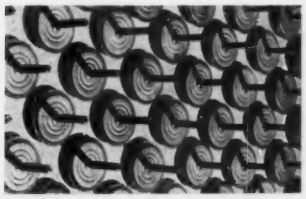
Circle 791 on page 19

Metallic Diaphragms

have hysteresis deviation under ¼ per cent

Pressure - sensing metallic diaphragms are offered in conventional form, for application in altimeters, aneroid barometers, airspeed indicators and pressure gages, and in nested form, for ap-

plications requiring overpressure resistance to absorb great pressure changes which would collapse conventional metallic units. Each element is fully resistance welded.



Diaphragms are available in Ni-Span C and 17-7PH as well as other stainless steel alloys and weldable metals. Sizes range from under 1 in. to over 3 in. in diameter, with hysteresis deviation of less than ¼ per cent. **Bellofram Products Corp.,** Blanchard Rd., Burlington, Mass.

Circle 792 on page 19

Copper-Clad Teflon

for printed circuits and cable strips

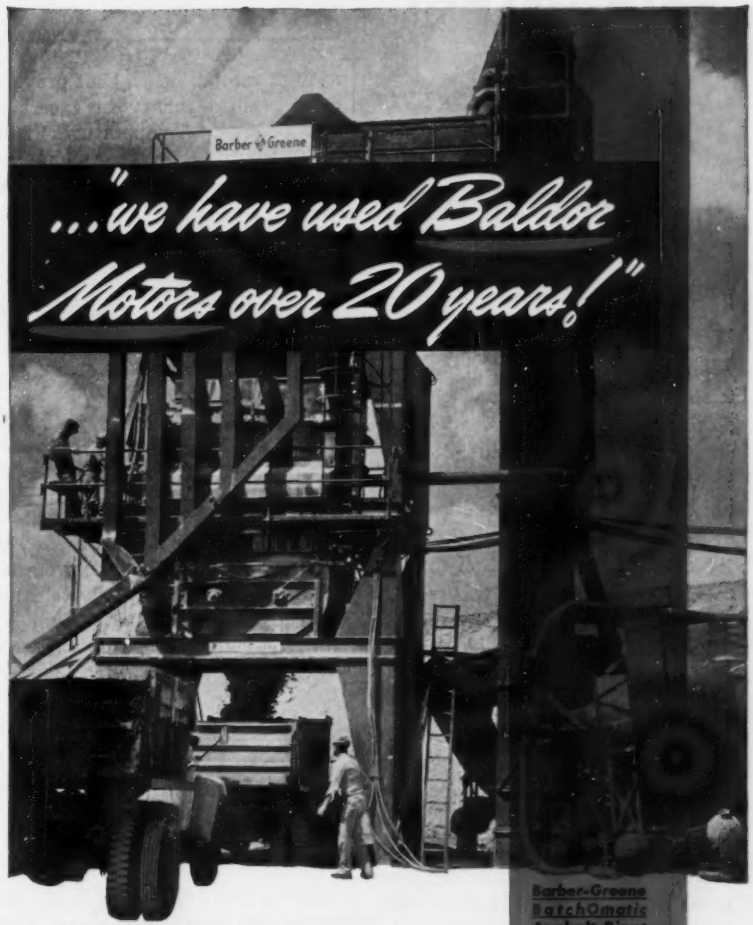
Chemelec copper-clad Teflon sheet and tape for printed circuit and cable strip applications assures a uniform dielectric constant, and no delamination of insulating material is possible. Material has bond strength greater than 7 lb per in. peel back and is unaffected by 500 F solder. It has low dielectric constant, dissipation factor, and water absorption. Sheet is 18 in. wide by 36 in. long, in Teflon thicknesses of 1/16, ⅛ and 3/16 in., with 1 or 2-oz copper on both sides. Tape 12 in. wide by 36 in. long is available in seven thicknesses from 0.005 to 0.060 in., with 1, 2 or 3-oz copper on one or two sides. It is also available with heavier copper, with copper on one side and cementable surface on reverse side, and in 12 by 150-in. size. **Fluorocarbon Products Inc.,** Div., U. S. Gasket Co., Camden 1, N. J.

Circle 793 on page 19

Variable Timer

operates in temperatures from −70 to 165 F

PM-47 variable electric timer provides for an adjustable time delay between 0.3 and 10 sec with accu-



Barber-Greene BatchOmatic Asphalt Plant

Up to 6 Baldor Streamcooled Motors are used to power these gigantic machines

BARBER-GREENE Depends on Baldor Streamcooled Motors to Power Its Asphalt Batch Plants & Belt Conveyors!

Despite the most torturous use, plus the constant hazard of dust and dirt, Baldor Streamcooled Motors keep famous Barber-Greene equipment operating at top efficiency, day after day.

This kind of superior performance has earned Baldor an enviable reputation among many outstanding heavy equipment manufacturers.

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Circle 559 on page 19

(Advertisement)

COLD HEADED FASTENERS COST LESS

and usually give better performance

The designer need not be restricted to standard fastener sizes when they do not meet the requirements of his application. It is often much less expensive to specify a rivet, nail, screw, pin or stud to meet the task exactly as the application requires, than it is to compromise its function for the sake of "standards." In this regard, we offer the equally important advantages of flexibility according to our customers' design changes and production by high speed, quantity techniques. While there is nothing mysterious about the cold heading process, experience has proved it to be of inestimable value for getting maximum quality and output at a minimum cost. While the really spectacular advantages in cost show up in runs of several thousand pieces, we are also able to take care of your short run requirements. We welcome and expect manufacturers to come to us for advice and assistance concerning their fastener problems.

Given complete specifications, including a drawing and an idea of the application, we can quickly tell you whether or not it will be advantageous to have your fastener or part JOB-DESIGNED by HASSALL. The remaining important aspect of our service to you is the ability to get into production quickly and make prompt shipment.

Write for a copy of our new booklet, "What the Designer Should Know about Cold Heading."

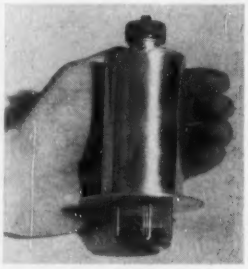
John Hassall, Inc.

P. O. Box 2197
Westbury, Long Island, N. Y.
Manufacturers Since 1850

Circle 560 on page 19

New Parts

racy of ±5 per cent. Unit provides output pulse energy in excess of 35,000 ergs. Temperatures from −70 to 165 F and accelerations to 100 *g* do not affect operation.



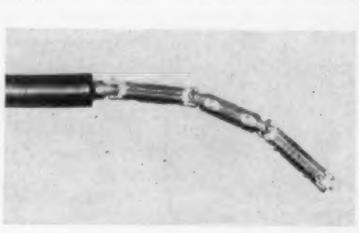
Timer is for use in missile systems and airborne applications, pilot escape systems, sled timers, programming devices and explosive element initiation. **Universal Winding Co. Inc.,** Patterson-Moos Div., 90-28 Van Wyck Expressway, Jamaica 18, N. Y.

Circle 794 on page 19

Flexible Link Shaft

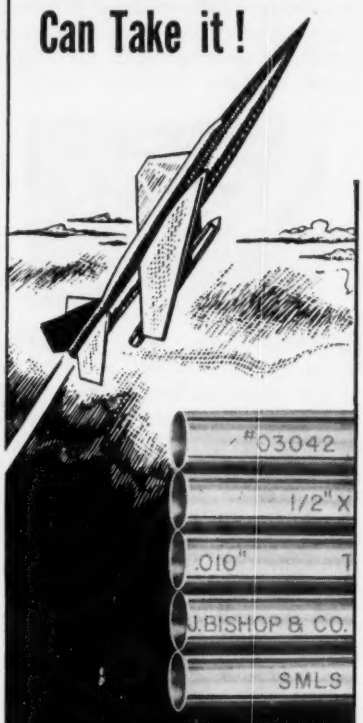
has equal torque in both directions

Flexible link shaft is available with unlimited length and equal flexibility in all sizes from ⅜ to 3 in. in diameter. Used for remote controls and power drives, it has equal torque in both directions. Links consist of trunnion blocks and two half links fastened together with screws or rivets. Cover materials include armored neoprene hose, nonmetallic hose,



or semirigid tube. Minimum link length is three times the diameter, and various link lengths can be combined in one shaft using long links for straight runs. Torque ratings for manual torsional movement range from 50 to 2500 lb-in. For motor drives at 1750 rpm, ⅛ hp requires ⅜-in. shaft, 1/3 hp requires ½-in. shaft, and 1 hp

BISHOP TUBING Can Take it!



That's why more and more aircraft, rocket and missile manufacturers are *specifying* BISHOP TUBING for engine parts and assemblies to withstand the corrosion, high temperatures, resistance to oxidation, vibration, stress and shock required by today's high speed aircraft.

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MANUFACTURERS OF: Seamless and Welded and Drawn Stainless Steel Tubing (.008" to 1" OD), Mechanical, Capillary, Hypodermic, Aircraft, Nickel and Nickel Alloy Tubing (up to .625" OD), Tubular Fabricated Parts, Glass-to-Metal Sealing Alloys, Clad Metals and Composite Wires, Platinum Group Metals and Chemicals.

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Quality Metal Craftsmen for Over a Century

Circle 561 on page 19

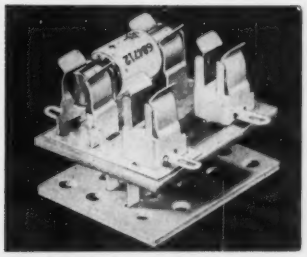
requires ¾-in. shaft. **Clark Flexible Link Shaft Co.**, Box 73, Newton Highlands 61, Mass.

Circle 795 on page 19

Silicon Rectifier Holder

provides positive polarization and seating

Designed especially for the Sarkes Tarzian silicon rectifier, this unit provides positive polarization in that rectifier and cannot be assembled in other than the correct way. Positive seating assures uni-



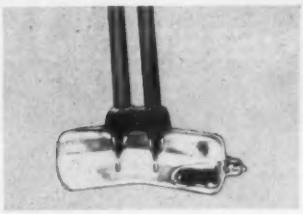
form surface contact between rectifier and clip. Design of holder permits specifying location of terminal. Connections can be made both from above or below chassis. Unit resists approximately 13 lb direct pull. **Illinois Tool Works,** Fastex Div., 195 Algonquin Rd., Des Plaines, Ill.

Circle 796 on page 19

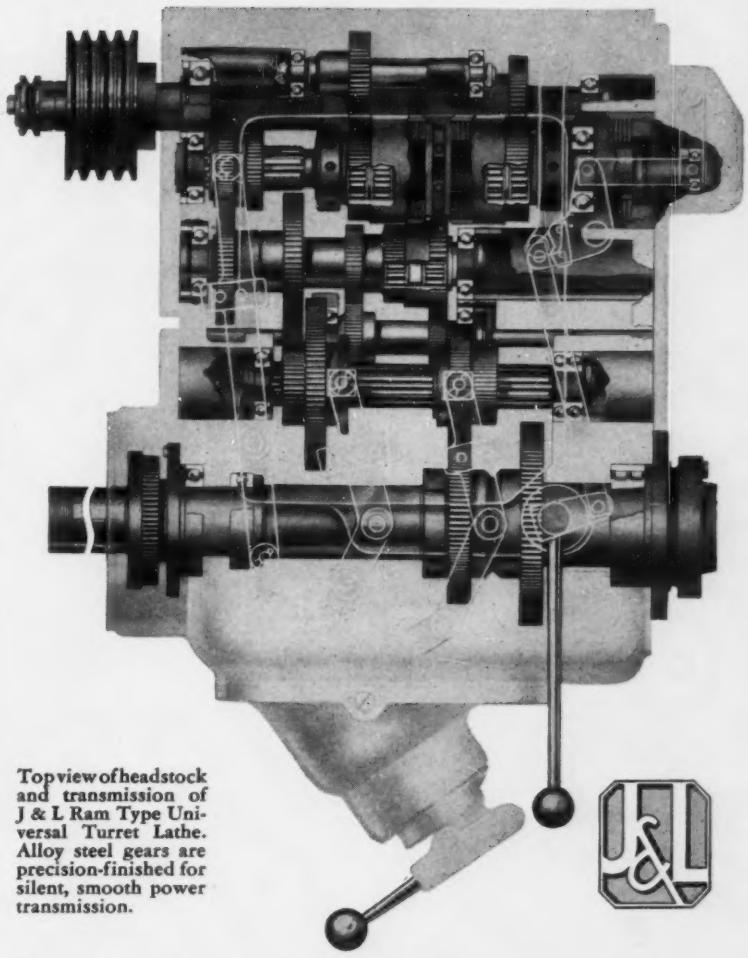
Mercury Switch

has positive pulse actuation

AS702B mercury switch, with applications in business machines, call systems, counting devices, electric fences, inching circuits and



other devices, features positive-pulse actuation. High surface tension of mercury in switch and double incline of bent tube pull mercury through closed contact position without contact welding or dead break. Mercury is in mo-



Top view of headstock and transmission of J & L Ram Type Universal Turret Lathe. Alloy steel gears are precision-finished for silent, smooth power transmission.

Perkins Gears Used by Jones & Lamson

Jones & Lamson Machine Company, famous as manufacturers of the world's most accurate and powerful turret lathes, use Perkins precision gears for efficient, dependable performance. Perkins custom-cut gears are precision-made to exact specifications. They eliminate wear, noise and backlash. Our OEM customers know Perkins means dependable service and longer gear life. Perkins' long experience in producing precision gears could bring profitable benefits your way, too! Ask our engineers to work with you designing or estimating your next gear order.

WRITE TODAY for folder showing bevel, spiral, helical and spur gears; ratchets, sprockets and ground-thread worms; face gears, generated and curvic clutches; made by Perkins in many sizes from all materials.

Perkins Machine & Gear Co., West Springfield, Mass.

Name_____

Company_____

Address_____

PERKINS

MACHINE AND GEAR CO.

Dept. 43, West Springfield, Mass.
Telephone: REpublic 7-4751

Circle 562 on page 19

NEW!

Miniature telephone type relay has superior shock/vibration resistance

NEW
POTTER & BRUMFIELD
MG SERIES RELAY

Unusual for a telephone type relay, the MG Series has excellent stability under high shock and vibration conditions. Tests show this miniature, light weight (only 1.2 oz., open) relay withstands vibration of 10g 55 to 500 cycles per second and will operate under shock to 30g according to Mil-R-5757C.

The superior performance of the MG is due in part to its unique single stack construction and to an exclusive hinge design which provides zero heel gap.

Open, dust covered or hermetically sealed, the MG is available with contact arrangements up to 4 Form C (4PDT). It is rated for ambient temperatures of −55°C to +85°C. A high-temperature version with a range of −65°C to + 125°C will soon be available. Write or wire today for complete specifications and delivery.

POTTER & BRUMFIELD, INC., PRINCETON, INDIANA—SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY

tion when circuit is made and cannot stop until it has passed through on-off position to other end of tube. Unit can be used for direct one-to-one revolution counting on slow-rotating devices. Models are available with or without terminals and 7-in. lead wires. Circuit arrangement is single-pole single-throw, momentary contact. Electrical rating is 1 amp resistive, 115 v ac. **Minneapolis-Honeywell Regulator Co.,** Micro Switch Div., Freeport, Ill.

Circle 797 on page 19

Linear Accelerometer

maintains constant damping without warm-up

Type LA-500 linear accelerometer is a true linear, nonpendulous type instrument, insensitive to cross-coupling accelerations. It is available in ranges from ±1 to 60 *g* and can be provided with two potentiometer pickoffs. Essentially constant damping is maintained

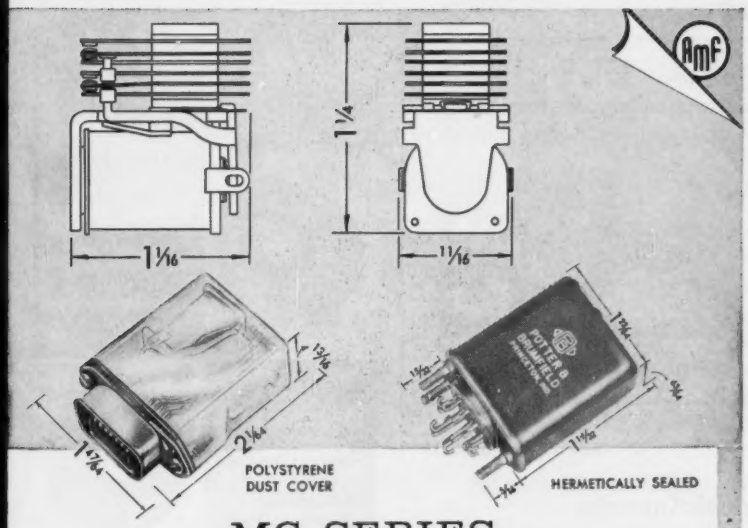
automatically throughout entire operating range of −65 to 175 F with no warm-up time required. Accelerometer is suited for aircraft and missile applications. It has a diameter of 1 7/16 in., is ¾ in. long, and weighs 1 lb. **Minneapolis-Honeywell Regulator Co.,** Boston Div., 1400 Soldiers Field Rd., Boston 35, Mass.

Circle 798 on page 19

Subminiature Capacitor

has diameter of 0.145 in. and length of ¼ in.

STNT subminiature tantalum capacitor is available in five ratings from 40 mfd, 3 v to 4 mfd, 50 v. It operates over a temperature



MG SERIES

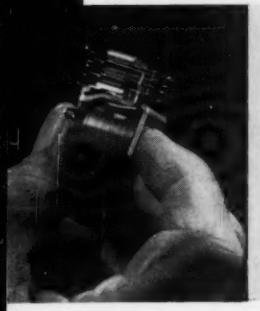
TERMINALS:
Open Relay: Pierced Solder Lugs.
Contacts: Two #18 AWG wires. Coil: Two #20 AWG wires.
Hermetically Sealed:
Miniature plug-in header with 7, 9 or 14 pins. Multiple Solder header with hook and terminals for three #20 AWG wires.
Polystyrene Dust Cover: Micro Ribbon plug-in type.
Mating receptacle: Amphenol #57-20140 or similar.
INSULATION RESISTANCE: 100 megohms min.
VIBRATION: .065" excursion 10-55 cps.
10g 55-500 cps. upon request.
SHOCK: 30g according to Mil-R-5757C upon request.
TEMPERATURE RANGE: −55°C to +85°C.
WEIGHT: 1.2 ozs. (open) 2.0 ozs. (sealed).
PULL-IN SPEED: Approximately 15 ms at nominal voltage.
DROP-OUT SPEED: Approximately 10 ms at nominal voltage.
CONTACTS: 3/32 silver.
CONTACT ARRANGEMENT: 4 pole, double throw (4 Form C).
COIL POWER: 3 watts max. DC @ 25°C. Continuous duty.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC, ELECTRICAL AND REFRIGERATION DISTRIBUTORS
See our catalog in Sweet's Product Design File.

Potter & Brumfield, inc.
PRINCETON, INDIANA

SUBSIDIARY OF AMERICAN MACHINE & FOUNDRY COMPANY
Manufacturing Divisions also in Franklin, Ky. and Laconia, N. H.

Mail the coupon below for further engineering data on P&B's MG Relay *plus* new compact catalog of standard type relays. If you need answers to a specific application problem, write in detail.



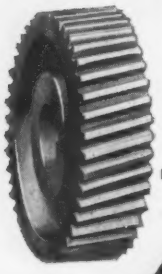
Potter & Brumfield, Inc., Princeton, Indiana
Attn: T. B. White, Brig. Gen. USMC (Ret.)
Special Projects Engineer

Please send me complete engineering data on the MG Relay plus the new compact catalog of P&B standard relays.

Name_____
Company_____
Address_____
City_____ Zone_____ State_____

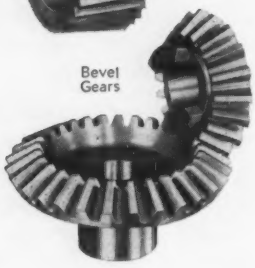
Circle 563 on page 19

GEARS

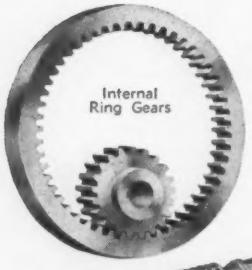


Symbol of QUALITY

Helical Gears



Bevel Gears



Internal Ring Gears

Worm Gear & Shaft

Industrial Gear offers a complete line of the finest cut gears available for the equipment of America. **Plus** — a combination of precision and quality, reasonable costs, and superb service.

INDUSTRIAL GEAR MFG. CO.
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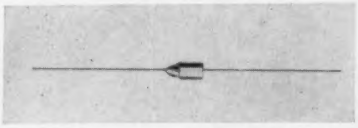
Chicago 24, Illinois

Circle 564 on page 19

New Parts

range from −55 to 85 C. Capacitor features a metal case, true hermetic seal, axial leads, and high re-



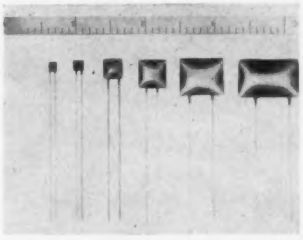
sistance to mechanical shock. Unit is ¼ in. long and 0.145 in. in diameter. **P. R. Mallory & Co. Inc.,** 3031 E. Washington, Indianapolis, Ind.

Circle 799 on page 19

Ceramic Capacitor

is miniature high-temperature unit

Val-Cap miniature ceramic capacitor maintains 90 per cent of room temperature capacitance at temperatures from −55 to 150 C. Capacitor is available in ten ca-



pacitance ratings from 47 to 100,000 mmf. Use of a high-density ceramic material possessing high dielectric constant and stable temperature coefficient makes possible high performance characteristics. **National-El Ray Corp.,** 11815 Vose St., North Hollywood, Calif.

Circle 800 on page 19

Pushbutton Stations

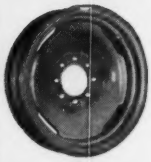
have base-mounted control mechanism

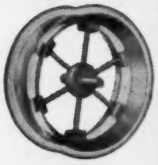
Series BA standard-duty pushbutton stations have reversible formed-steel base, base-mounted control mechanism, and front accessible wiring terminals. Controls are furnished with one normally open contact, one normally closed contact, or one normally open and one normally closed contact on each button. Two or three-button units are standard. Wrap-around cover, molded of glass fiber-

ELECTRIC
Wheels · Axles · Spindles

DIVIDED WHEELS
Generally used as dolly, tail or caster wheels

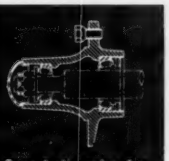
FOR TRUCK TIRES
Full drop center rim to utilize used truck tires on larger implements



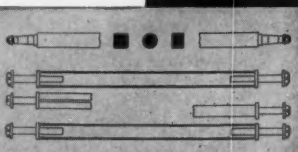


PLANTER WHEELS
Steel rim or for use with planter rubber tires

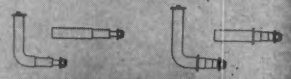
SIX BOLT SERIES
Light and heavy—widest range of implement use



Four bolt series for light implements



Hub and bearing combinations available. Stub spindles and full length axles.



Our Engineers Invite Your Inquiries

ELECTRIC WHEEL COMPANY
DIVISION OF THE FIRESTONE TIRE & RUBBER COMPANY
2809 SPRUCE · QUINCY, ILLINOIS

Circle 565 on page 19

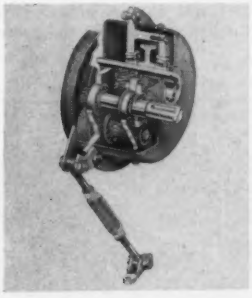
reinforced alkyd, has natural insulating properties and withstands rough handling. Ac contact ratings are 3 amp, 110 v; 1.5 amp, 220 v; 0.75 amp, 440-480 v; 0.6 amp, 550-600 v. Dc ratings are 1.1 amp, 115 v; 0.55 amp, 230 v; 0.2 amp, 550-600 v. **Furnas Electric Co.**, 1045 McKee St., Batavia, Ill.

Circle 801 on page 19

Shaft-Mounted Drive

now available with higher ratios

All-steel, double-reduction, shaft-mounted drives include a higher ratio of 24:1 or 20:1 in two smaller sizes. Outside dimensions and torque rating remain the same. Advantages of higher ratio units include use of smaller sheaves to obtain a given output speed, and



use of a 1750-rpm motor. Units are available for horizontal and vertical application, in ½ to 30-hp ranges, with output speeds as low as 5 rpm. **Falk Corp.**, Dept. 255, 3001 W. Canal St., Milwaukee 1, Wis.

Circle 802 on page 19

Four-Way Valve

10,000-psi unit accommodates liquids and gases

New four-way valve is available in pipe sizes from ¼ to 1 in. The 10,000-psi unit withstands surges

SEMS BY Everlock®

HOLD TIGHTER! COST LESS!

Ever hear someone say "they don't make 'em like they used to"? Well, it's a good thing they don't! Modern autos, for instance, last up to three times as long as the cars of twenty years ago.

Sems by Everlock are one of the reasons. Every modern auto has a thousand and one places where Sems grip tight for the lifetime of the car. The illustration shows Sems used on a station wagon tailgate. Often used for both business and pleasure, station wagons get abuse and vibration that are sure to work old-time fasteners loose. But, Sems by Everlock actually hold tighter the more you try to shake 'em loose.

Here's Why You Should Order SEMS by Everlock . . .

1. **Cut costs** by eliminating separate handling of screw and washer.
2. **Simplify ordering** by reducing the number of items carried and quantities stocked.
3. **Eliminate waste** due to lost lock washers.
4. **Eliminate rejects** due to omitted lock washers.
5. **Fast delivery** on a wide range of sizes, types and finishes.

Everlock Sems are available in a wide range of types and sizes. Ordering "Sems" is not enough, only Everlock Sems, preassembled lock washers and screws, have the exclusive, full chisel edge locking action.

Other Everlock fasteners that feature the exclusive full chisel edge locking action include **Free Lock Washers, Locknuts and Terminals.**

THOMPSON-BREMER & CO.
Dept. L-520 N. Dearborn Street • Chicago 10, Illinois
Subsidiary of AMERICAN MACHINE & FOUNDRY CO.

WRITE FOR FREE CATALOG . . .

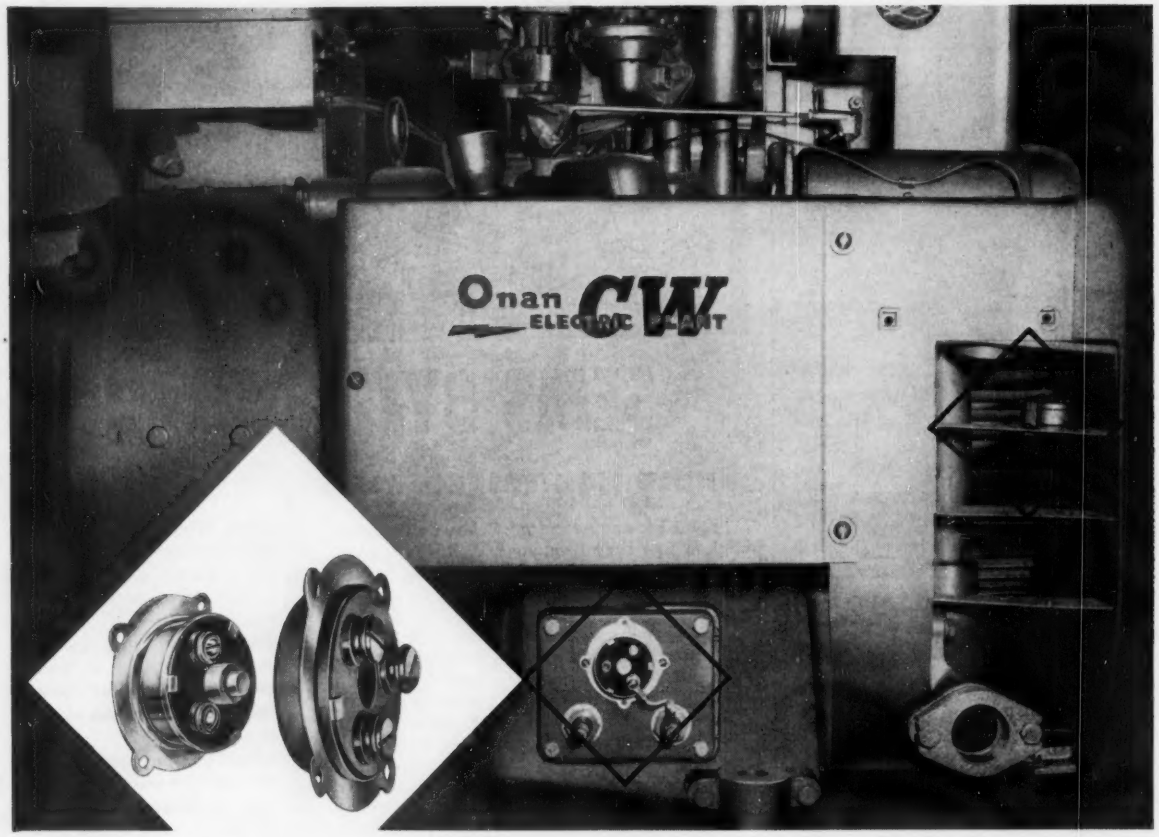
Another AMF Product
Everlock
INDUSTRIAL FASTENERS

Check the Alphabetical Listing in Your Telephone Book:

EVERLOCK REPRESENTATIVES

J. J. McIntosh, Atlanta, Georgia
C. L. Martin Sales Corp., Baldwinsville, N. Y.
Richard C. Dudek, Beverly Hills, Calif.
W. L. Barth, Jr., Chicago, Illinois
Scott & Steffen, Inc., Cleveland, Ohio
Kenneth D. Delaney, Dayton, Ohio
Sam T. Keller Co., Detroit, Michigan
C. W. McNeil, Inc., Houston, Texas
D. G. Teeling Co., Indianapolis, Ind.
Plastic & Metal Components, Boston, Mass.
Thom Lundeen, Moline, Illinois
J. Ramsey Reese, Inc., New York, N. Y.
Hank Workman, Pleasure Ridge, Ky.
W. Henry Cordray Sales Co., Philadelphia, Pa.
Oregon Indust. Factors, Portland, Oregon
Howard N. Clark, Rochester, N. Y.
Forrest Moschner, St. Louis, Mo.

Circle 566 on page 19



KLIXON

FIXED TEMPERATURE CONTROLS

This is the Onan CW Electric Generating Plant which uses one Klixon Thermostat to keep oil in the oil base at a set temperature to facilitate cold weather starting and another as an overheat safety cut-off. These Onan 7½ and 10KW electric plants play an important role in long line natural gas transmission and many other industrial operations.

Assure top performance in Onan Electric Generating Plants

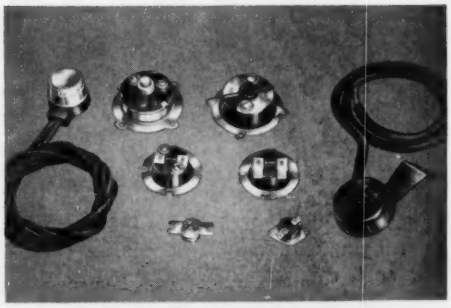
D. W. Onan & Sons Inc., of Minneapolis, manufactures a complete line of electric generating plants for emergency standby service, for portable service, for mobile service and for stationary service. And, says R. O. Overby, Assistant Chief Engineer for Onan:

"We have been using Klixon Thermostats for many years in safety cut-off devices and in temperature control applications on our generator sets. They have proven to be highly effective, dependable and economical. As a result, we give first consideration to Klixon when any new temperature control requirement comes up in our products."

Among the many Onan plants using the Klixon fixed temperature controls are the Onan water-cooled marine models, the air-cooled models which are equipped with automatic air shutters and the various standby units which utilize oil base heaters.

Onan is one more company on the long list of equipment manufacturers who continually specify and use Klixon Controls.

Klixon Controls are available in many hermetically sealed and open types in a wide variety of operating temperature ranges. Klixon engineers, specialists in temperature control applications, can help you work out your specific application details. Write for THSN catalog sheets.



Typical KLIXON Fixed Temperature Controls used in many applications, including examples of the new 202 series for home appliances.

METALS & CONTROLS CORPORATION

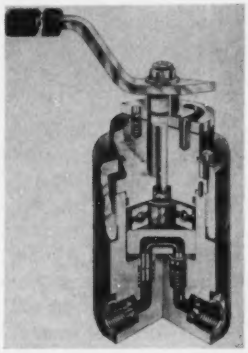
Spencer Thermostat Division

3209 Forest Street, Attleboro, Mass.

KLIXON®

Circle 567 on page 19

up to 15,000 psi and has burst pressure of 30,000 psi. Lapped, optically flat, metal-to-metal sealing surfaces of sealing rings and mating rotor face always maintain



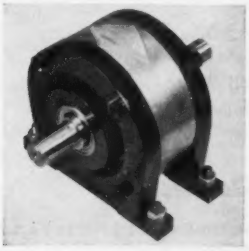
intimate contact; flow travels only through center of seal. Valve accommodates liquids and gases. **Barksdale Valves,** 5125 Alcoa Ave., Los Angeles 58, Calif.

Circle 803 on page 19

Gear Reducers

have torque capacities up to 25,000 lb-in.

Compact, heavy-duty gear reducers with shafts in line are built for ratios from 3:1 to 300:1 in single-stage units and to 50,000:1 in two-stage units. Reducers have gear-tooth contact over 120 deg of circumference. They have torque capacities up to 25,000 lb-in. Units are arranged for bolting and con-



nection to standard flange-type motors up to 10 hp. **Odin Corp.,** Castleton, Ind.

Circle 804 on page 19

Miniature Relays

for printed circuits

Class-II printed-circuit relays are adaptable to low-voltage applications and for requirements where one relay must perform a number

NATIONWIDE
SERVICE by ARWOOD
. . . our reputation is built on it
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Fifty-four skilled and experienced ARWOOD field engineers are at your service in 20 major industrial centers throughout the country. They are experts in design and production engineering, with a fund of Investment Casting knowledge at their fingertips, to do only one thing —Help you!
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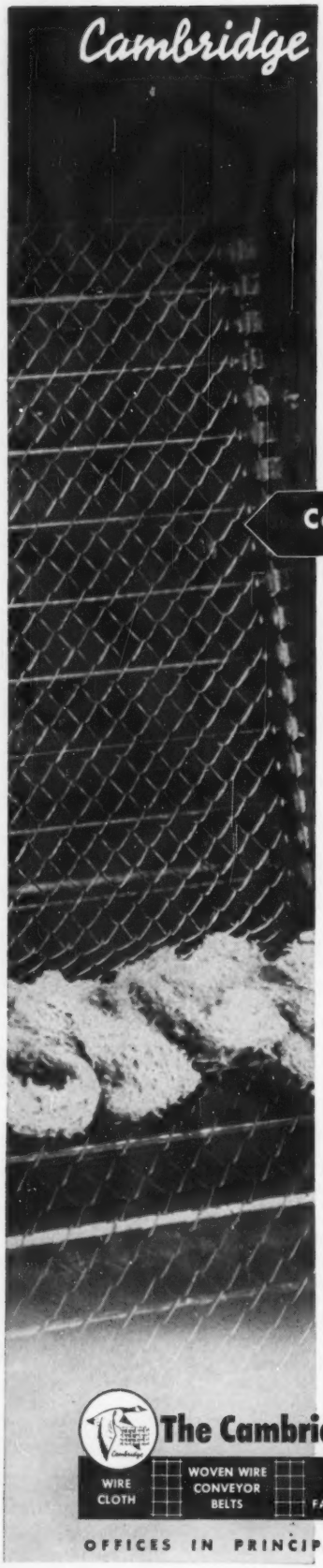
Circle 568 on page 19



Cambridge

WOVEN WIRE BELTS

combine movement with processing to lower costs

Regardless of what you process . . . metal parts, food products, chemicals, plastics, ceramics or glass . . . a continuous belt-to-belt flow on woven wire conveyor belts combines movement with processing to eliminate batch handling and cut operating costs. Controlled speeds through any type of manufacturing process . . . hot or cold, wet or dry . . . increase product uniformity and help maintain capacity production. EXAMPLE:

Continuous Drying

MOVING BELTS carry fibres through drying oven in steady, continuous operation.

OPEN MESH allows free circulation of heat or process atmospheres around all parts of product. In washing or chemical treating operations, open mesh permits quick drainage of process solutions, uniform treatment of material.

ALL METAL BELT easily withstands temperatures from sub-zero up to 2100°F.; rust-proof alloys can be used for operation in corrosive conditions.

WOVEN WIRE CONSTRUCTION provides extra strength, extra long life. There are no seams, lacers or fasteners to break or wear.

SPECIAL RAISED EDGES or surface attachments are available to hold even smallest parts in position on the belt during flat or inclined movement.

Regardless of your industry . . . metal working, food, chemical, glass or ceramics . . . you'll find combined movement and processing practical and economical in machines for your own operation or for resale. Cambridge Woven Wire Conveyor Belts are made in any size, mesh or weave, from any metal or alloy to do the job you want . . . hot or cold, wet or dry. Call your Cambridge Field Engineer to discuss how you can cut operating costs with woven wire conveyor belts. Look under "Belting, Mechanical" in the *Yellow Pages*. Or, write for FREE 130-PAGE REFERENCE MANUAL.

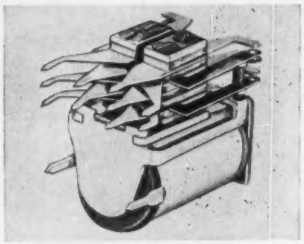
The Cambridge Wire Cloth Co.

WIRE CLOTH | WOVEN WIRE CONVEYOR BELTS | WIRE CLOTH FABRICATIONS

Department N, Cambridge 9, Maryland

OFFICES IN PRINCIPAL INDUSTRIAL CITIES

New Parts



of switching functions with minimum input power. Units are available with excellent resistance to shock, vibration and wide temperature variations in compliance with military specifications. They are offered for dc operation in any voltage to 230, also with full wave rectification for operation from 20 to 400 cps. A variety of contact combinations is also available. **Magnecraft Electric Co.**, 3350T W. Grand Ave., Chicago 51, Ill.

Circle 805 on page 19

Insulating Fabrics

for service to 1500 F

Two insulating ceramic-fiber fabrics are available in various widths or thicknesses for positive high-temperature insulation. They are also supplied as instrumentation tapes for insulation and leak detection. Tape withstands temperature of 1500 F, and can be wrapped in spiral form around pipe as small as ½ in. in diameter. Fabrics can be treated with silicone rubbers, epoxy resins, or can be impregnated with phenolic resin and molded into various shapes. They can also be woven in tubular form. **Russell Mfg. Co.**, 293 E. Main St., Middletown, Conn.

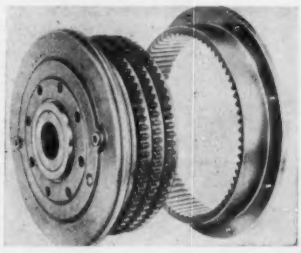
Circle 806 on page 19

Air Clutches

have maximum torque capacity of 3503 lb-ft

New 8, 10, and 11½-in. air clutches are suited for machinery and equipment where high torque capacity and long life are required. They are available in triple, double, and single-plate construction, and have maximum torque capacity of 3503 lb-ft. Cartridge-type diaphragm, of neoprene reinforced with nylon, eliminates leakage, provides uniform torque and auto-

matically compensates for wear without adjustment. Clutches have narrow widths that permit their replacing drum or band clutches. They are of heavy-duty construc-



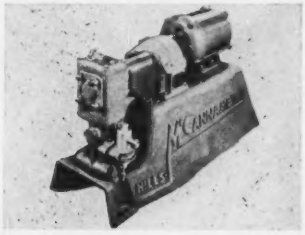
tion and utilize thick, cast-iron center plates for maximum heat distribution. **Twin Disc Clutch Co.**, Racine, Wis.

Circle 807 on page 19

Diaphragm Pump

packless unit is for pressures to 2500 psi

Packless diaphragm pump for proportioning and metering fluids has a diaphragm consisting of solid Teflon permanently bonded to and covering face of an elastomeric backing. Pump performs with accuracy and minimum maintenance at pressures to 2500 psi, and pro-



vides continuous flow in a wide output range. **Hills-McCanna Co.**, 2437 W. Nelson St., Chicago 18, Ill.

Circle 808 on page 19

Rotary Actuator

develops 150 to 300,000 lb-in. torque

Rotac has many applications in pulling, pushing, opening, closing, lifting, and lowering movements. Power is obtained from oil, water, or air. Unit is composed of a cylindrical chamber containing a stationary stop, and central shaft on which a vane is fixed. As-

(*Please turn to Page* 268)

Felt
can be made
"TOUGH
AS NAILS"

. . . or soft as a cotton ball! The range of densities and the surfaces and finishes you can get with Felt by Felters are truly amazing!

Measured in pounds per square yard, felt goes all the way from 0.81 lbs. for ⅛" to 8.4 lbs. for ½", with greater ranges on special order. The hard, rough, hornlike fibres form an excellent material for glass polishing and give exceptional wearing qualities when in contact with moving machinery parts. And fine, sanded surfaces are ideal for lubricating and filtering.

FELT IN USE . . . This manufacturer uses felt strips for buffing guides in their cylinder hones. Felt wears at same rate as stones to provide good bearing and cutting guide.

Send for FELTERS Design Book

20 pages of "Facts" on how you can use the unique properties of felt. It's yours for the asking, sent to help you build a better product. Send for it today: The Felters Company, 242 South Street, Boston 11, Mass.

Get the Best, Specify

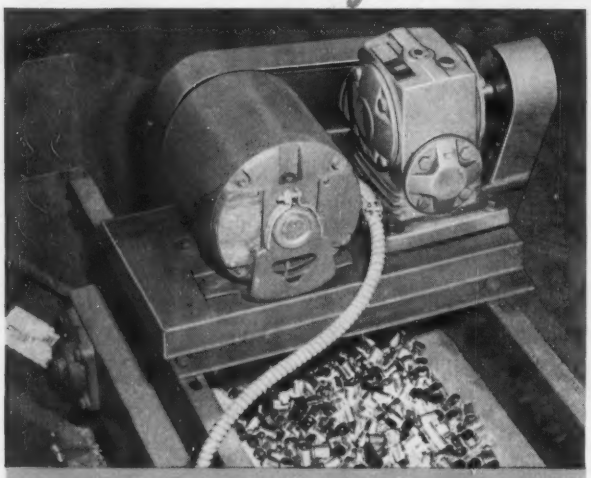
Felt by Felters

FE5-26

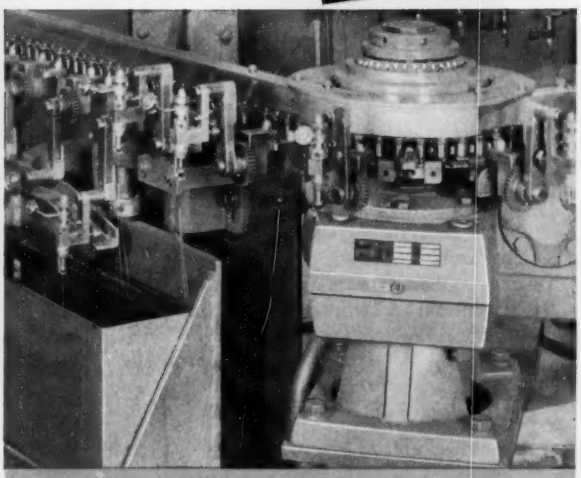
242 South St., Boston 11, Mass. *Manufacturers of Felt and Felt Products*

Cost-wise design calls for STANDARDIZED BOSTON Gear SPEED REDUCERS

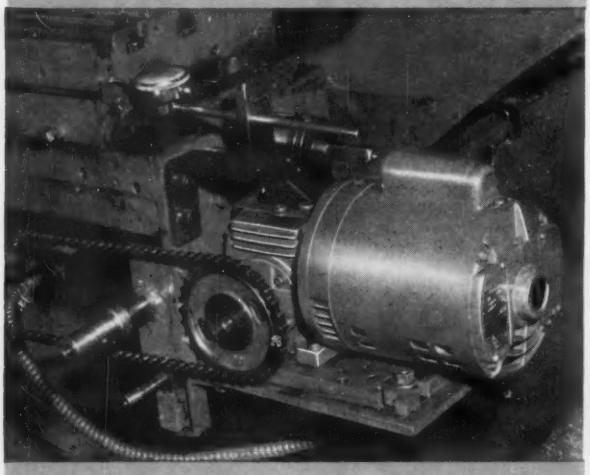
FROM STOCK!



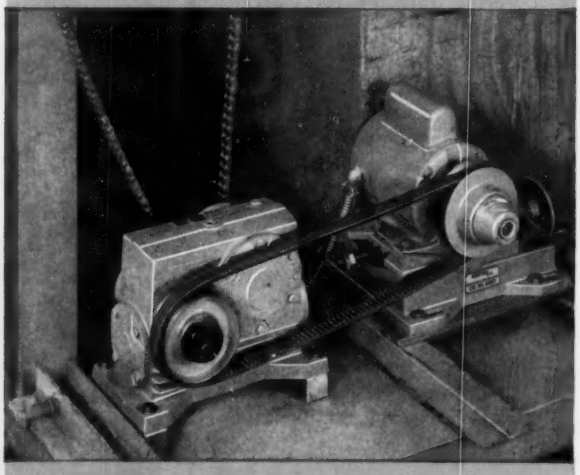
LASTING POWER ECONOMY, long wear, easy maintenance and quiet operation make Boston Gear Speed Reducers the practical choice for drives in materials handling equipment. A 100 Series Model T Reductor is used in the conveyor drive illustrated, where production of 4,000,000 lamp bases per day requires continuous, trouble-free operation.



COST OF SPECIAL MACHINES IS MUCH LESS when designed around Boston Gear standardized stock components. A 100 Series Model VMW Ratiomotor drives this automatic stripping and soldering machine for fuse plug lead wires. Assembly also includes standard stock Boston spur gears, rack, pillow blocks, pulleys, sheaves, and bushings.

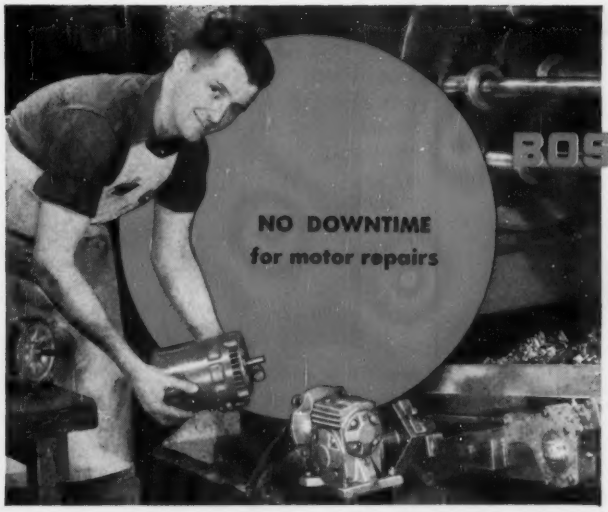


INCREASED COOLING EFFICIENCY of the finned housings of Boston Gear Speed Reducers dissipates heat rapidly. This permits compact design and higher torque capacity, of special advantage in machine tool drives like the 100 Series Model M Ratiomotor illustrated, and where space is limited, or where high area temperatures prevail.



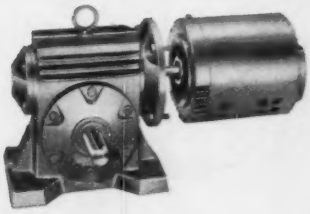
STANDARDIZED VARIABLE SPEED DRIVES, assembled from Boston Gear stock parts, simplify the design job, and save the time required to procure special equipment. The illustration shows a Boston Gear Variable Speed assembly with a Type TW Reductor, used with Boston stock sprockets and chain to drive conveyor belt of a heat-treating furnace.

Since Boston Gear *standardized* Speed Reducers take top-rating in any comparison — why pay more, why wait for "specials"? Your nearby Boston Gear Distributor can deliver any model you need, *from stock.* His factory-trained specialist will furnish any information you need to simplify drive design and assure lasting economy. Be cost-wise . . . STANDARDIZE and SAVE. Boston Gear Works, 64 Hayward St., Quincy 71, Mass.



DETACHABLE MOTOR DESIGN OF BOSTON Gear 100 RATIOMOTORS

permits motor change in minutes continued operation with spare.

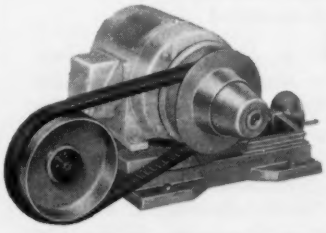


The standard end-mounted motor on all 100 Series RATIOMOTORS is easily detachable — can be changed quickly and easily. The gear assembly remains undisturbed, so no realignment is required.

The detachable motor design also makes any 100 Series RATIOMOTOR readily adaptable to changing conditions of operation. You can easily replace the original motor with other types . . . totally-enclosed, explosion-proof, etc.

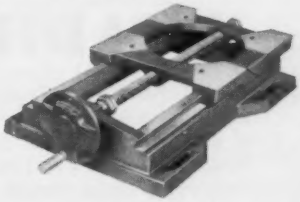
With today's production demands, you need the most dependable protection against downtime losses. Design around Boston Gear RATIOMOTORS and make this easy maintenance feature a money-saving advantage of your assemblies.

NOW — BOSTON VARIABLE SPEED DRIVES — FROM STOCK



For use with ½ and ¾ HP motors to provide constant torque, infinitely variable, 3 to 1 speeds — in any range between 1750 RPM and .5 RPM. Assembly of STANDARD STOCK parts includes adjustable Motor Base, self-contained, spring-tension Motor Pulley, flat driven Pulley, and heavy duty Belt.

BOSTON VARIABLE SPEED REDUCTOR DRIVES consist of above parts with addition of a 100 Series REDUCTOR — Type V, TW, V, or VW.



ADJUSTABLE MOTOR BASE

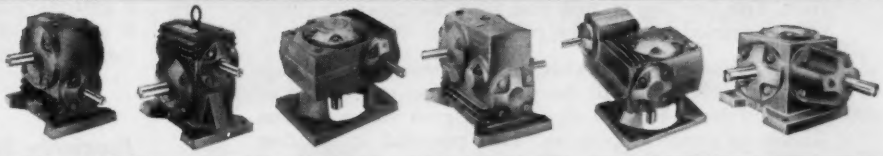
CALL YOUR **BOSTON Gear** DISTRIBUTOR

For nearest Distributor LOOK UNDER "GEARS" in the 'Yellow Pages'

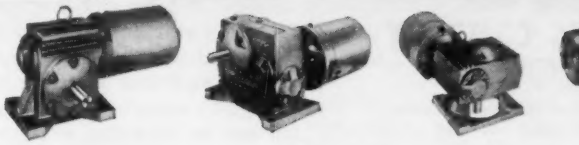
See Catalog No. 56 for complete specifications and selection data.

1605 TYPES and RATIOS **FROM STOCK** AT FACTORY PRICES

REDUCTORS Ratios 1:1 to 3600:1 .004 to 50 HP



RATIOMOTORS Output RPM .49 to 175



FLANGED REDUCTORS

Gear assemblies of Ratiomotors, sold without motors. You buy and attach your choice of motor.

THERE MUST BE AN EASIER WAY

—AND THERE IS WITH . . .

MIDLAND

WELDING NUTS

The Midland Steel Products Company is constantly developing new, progressive ideas to improve the efficiency of its fine products. It pioneered the *Midland Welding Nut,* for example, and so successful was this application in its own shops that this labor-saving device has been made available to others.

If you are a manufacturer of metal parts or products and have fastening, fabricating or assembling problems, you may find Midland Welding Nuts just the solution you've been looking for. The Nuts are easily welded into position for the lifetime of the product. You can be assured of correct fit, even in the most awkward, hard-to-reach places. Bolts turn easily into the applied nuts. Thus, heretofore two-man operations can be handled by one man in most instances. Weld-nut equipped parts will be preferred by your customers for they will find them cost-saving and trouble-free, cutting down assembly time. Too, you can be sure that your parts will be properly assembled without the risk of rattles.

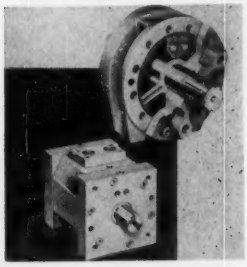
A few minutes' time in checking the assembly problems of your customers will be profitable to you. Midland Welding Nuts are low in cost, can give you a definite advantage over competition. This practical application is recognized internationally and endorsed by many designers of the finest products.

The MIDLAND STEEL PRODUCTS COMPANY

6660 Mt. Elliott Avenue • Detroit 11, Michigan
Export Department: 38 Pearl St., New York, N. Y.
Automobile and Truck Frames • Air and Vacuum Power Brakes
Air and Electro-Pneumatic Door Controls

New Parts

(*Continued from Page* 265)



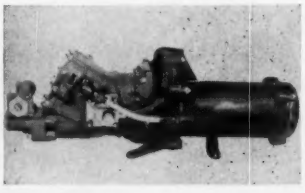
sembly is enclosed by cylinder end caps, through which shaft projects. When pressure is applied to either side of vane, shaft rotates in direction in which pressure is applied. Pressure reversals provide reciprocating movement, limited to maximum arc of 280 deg. Standard models develop 150 to 300,000 lb-in. torque at 1000-psi input pressure. **Ex-Cell-O Corp.,** Greenville Plant, 945 E. Sater St., Greenville, Ohio.

Circle 809 on page 19

Oil-Cooled Motorpump

for continuous-duty use in turbine-powered aircraft

Only 20 in. long and with motor diameter less than 4 in., this 12-hp motorpump is rated at 2000 hr service. Liquid cooling avoids duct work, providing savings in airframe space and weight. The 400-cycle, 200-v electric motor drives a variable - displacement piston - type



pump. Motorpump delivers up to 8 gpm at 2250 psi and reduces to 6 gpm at 2950 psi. **Vickers Inc.,** Detroit 32, Mich.

Circle 810 on page 19

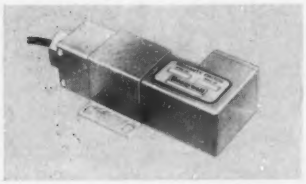
Proximity Switch

for detecting ferromagnetic objects

Proximity switch, designated 2FA1, can be mounted on a surface that extends only 3¼ in. from material which operates it. Switch is for use in detecting a ferromag-

Circle 572 on page 19

netic object without direct contact. It has no moving parts. Object passes through a magnetic field set up directly in front of switch sensing end, initiating a signal which flows through magnetic circuitry to operate a remotely located control relay. Unit



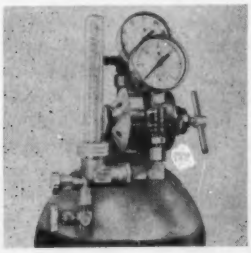
cannot be accidentally set in action by ferrous chips. Switching element and sensing unit are potted and enclosed within a heavy steel casing. **Minneapolis-Honeywell Regulator Co.,** Micro Switch Div., Freeport, Ill.

Circle 811 on page 19

Dual-Range Flowmeters

provide constant visual check of flow rate

Series 1600 dual-range flowmeters are designed for inert-gas welding, flushing molten metals, laboratory service, and other industrial applications. Rapid in-service switching from either flow range to the other is done by means of a piston-type selector valve. Flow rate within either range is controlled by a sensitive needle valve. Series includes seven direct-reading units, each for a specific gas,



and one general-purpose flowmeter, provided with calibration curves, which meters any of five gases. Combination of two or more units can be used to proportion a mixture of gases. **Air Reduction Sales Co.,** Div., Air Reduction Co. Inc., 150 E. 42nd St., New York 17, N. Y.

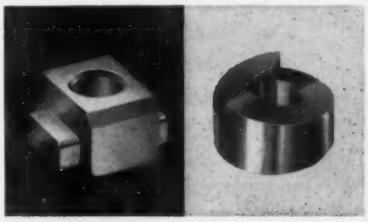
Circle 812 on page 19

A NEW FREEDOM IN BEARING APPLICATIONS

Availability of Sintered Powdered Metal Bearings and machine parts from a fully competent and technically responsible source opens the way to improvements in mechanical products.

Bunting facilities for designing, engineering and manufacturing of Sintered Powdered Metal Bearings and parts are as comprehensive and responsible as the traditional Bunting competence in the field of Cast Bronze Bearings.

A competent group of Bunting Sales Engineers in the field and a soundly established Product Engineering Department put at your command comprehensive data and facts based on wide experience in the designing and use of Cast Bronze and Sintered Powdered Metal Bearings and parts.



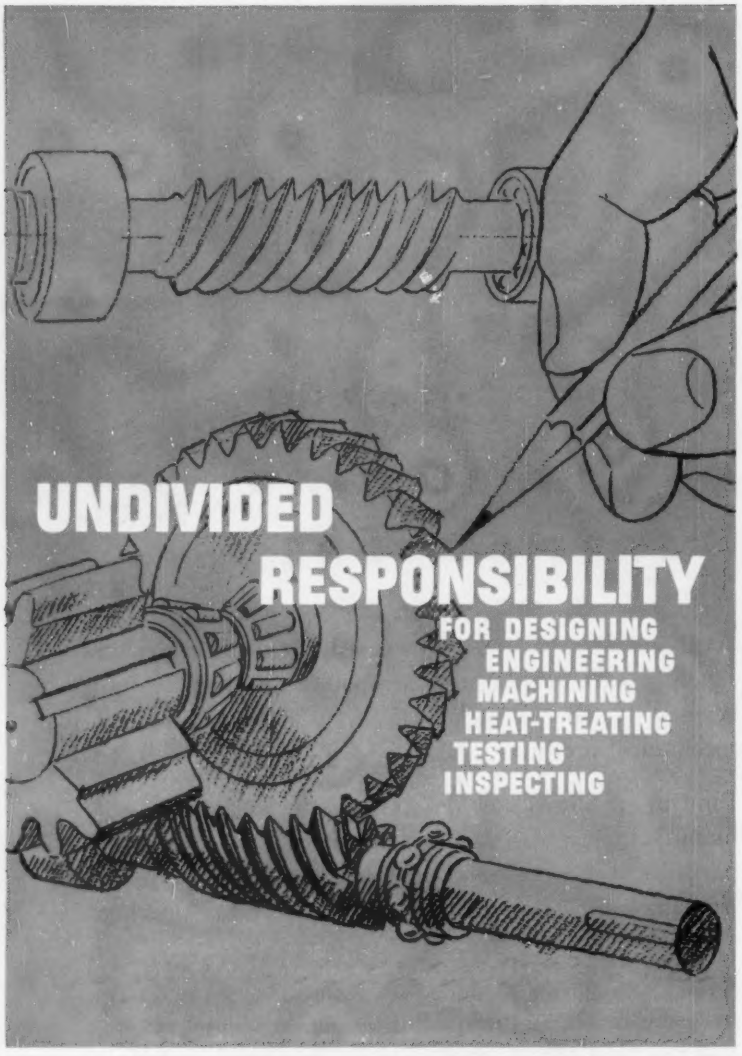
Write for catalogs and your copy of the new 24 page Bunting Engineering handbook of Sintered Powdered products and their composition, manufacture and application.

Bunting®

BUSHINGS, BEARINGS, BARS AND SPECIAL PARTS OF CAST BRONZE AND POWDERED METAL

The Bunting Brass and Bronze Company • Toledo 1, Ohio • Branches in Principal Cities

Circle 573 on page 19



• BRAD FOOTE Gears will perform satisfactorily when used in your shop —or on equipment you sell to others—because BRAD FOOTE can unconditionally guarantee their quality.

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AMERICAN GEAR & MFG. CO.
Phone: Lemont 920
Lemont, Illinois

PITTSBURGH GEAR COMPANY
Phone: SPalding 1-4600
Pittsburgh 25, Pennsylvania

Circle 574 on page 19

ENGINEERING DEPARTMENT
EQUIPMENT

Crayon Holder

can be adjusted with one hand

Mark I heavy-duty, pushbutton mechanical crayon holder, available for all general marking purposes, is adjustable with one hand. Knurled finger grip prevents slip-

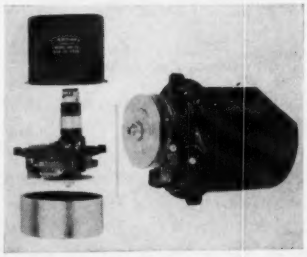
ping and permits easy maneuverability. Unit has corrosion-resistant, nonrolling square barrel, colored to identify refills within. **Alvin & Co.**, Palisado Ave., Windsor, Conn.

Circle 813 on page 19

Tape Recorders

miniature units have high-frequency response

Four miniature magnetic tape recorders are designed for acquiring essential instrument data in guided missiles, rockets, torpedoes, aircraft and other military vehicles. Commercial applications include oil and chemical processing operations. Designated MR-50 series, the recorders are seven-track units, providing six data tracks and one for timing. Transistorized



timing oscillator is built in. Standard tape speed is 15 ips for three models, and 30 ips for the fourth.

Westinghouse AV-DRIVE gives constant surface speed regardless of work diameter

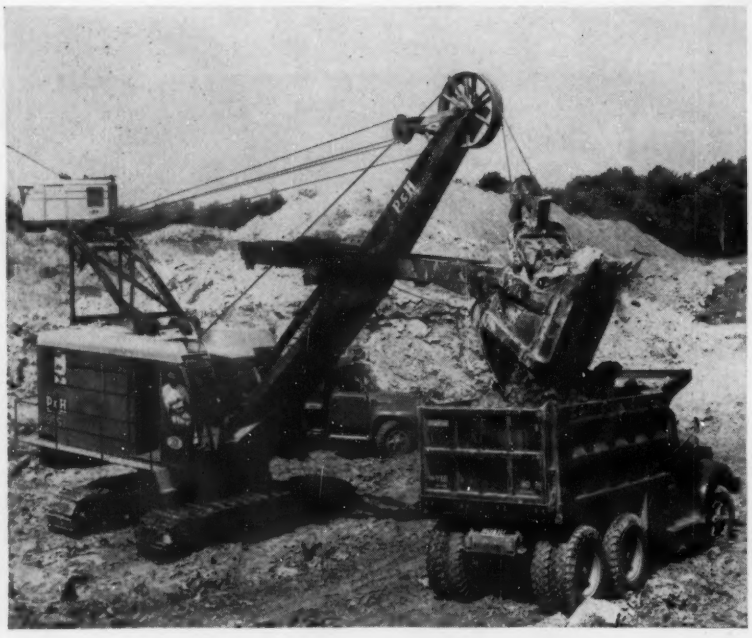
. . . at R. H. Bouligny, Inc., Charlotte, North Carolina

Eighteen hours a day, this tracer lathe is doing the work of an engine lathe . . . plus tracing at R. H. Bouligny, Inc., Charlotte, North Carolina. Constant surface speed, regardless of work diameter, is provided for precision template-guided cutting by a Westinghouse AV-Drive.

As the tracer mechanism traces over the template, the spindle speed is automatically controlled in accordance with tool position to maintain constant surface cutting speed. The template and work piece can be placed in the 20″ swing lathe and the machine takes over.

To learn how the versatile Westinghouse AV-Drive can make your production more profitable, call your local Westinghouse representative. Or, write Westinghouse Electric Corporation, 3 Gateway Center, P.O. Box 868, Pittsburgh 30, Pennsylvania. J-22052

YOU CAN BE SURE...IF IT'S Westinghouse

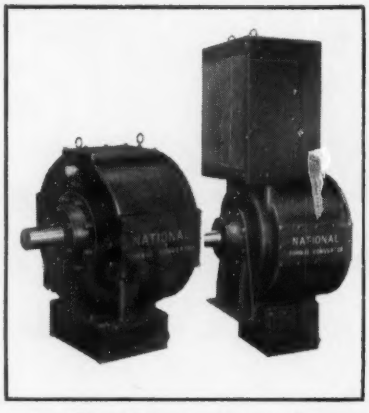


This Harnischfeger Shovel operates faster, smoother, easier, because of a National Torque Converter

If you've ever watched a shovel like this in action, you know how the operator makes it swing, travel and hoist all at the same time, starting and stopping each operation at will. And, if you stop and think, you'll recognize what a strain this rapidly varying load puts on the engine.

On the shovels produced by most of the nation's leading manufacturers, a National Torque Converter is installed to cushion this stress. All shocks are absorbed within the converter, which eases the wear on the equipment. Furthermore, the converter automatically delivers the power as needed for various operations. If a shovel hits a boulder, for instance, the converter reduces the bucket speed, and multiplies the "crowd," until the obstruction is cleared. The engine can't stall, as the converter exerts its greatest thrust when it encounters the greatest opposition!

The properties of torque multiplication and shock cushioning that make National Torque Converters



National Torque Converters are manufactured with or without integral cooling systems.

so valuable to shovel operators may also serve you. If you have any heavy equipment, powered by 100 to 1000 hp prime movers, that is subject to shock, strain and varying loads, the National Torque Converter can help you to increase output, reduce maintenance. Write:

THE NATIONAL SUPPLY COMPANY

INDUSTRIAL PRODUCTS DIVISION

Two Gateway Center, Pittsburgh 22, Pa.

Pace-setters in the progress of industrial power transmission

Circle 576 on page 19

Engineering Equipment

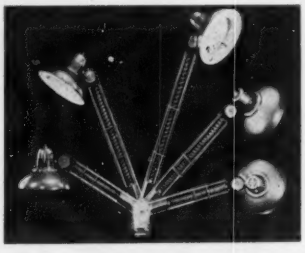
Recorders operate through at least 250 *g* shock axially and 50 *g* transversely, and survive 1200 *g* without major damage. **Northam Electronics Inc.,** 2420 N. Lake Ave., Altadena, Calif.

Circle 814 on page 19

Lighting Unit

rotates into any working position

Trombolite combines incandescent and fluorescent lighting to provide improved illumination over working areas. It can be rotated readily into any working position. Unit



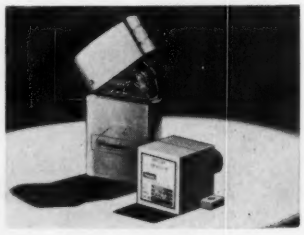
has many applications in lighting for engineers and draftsmen, and in scientific and professional use. **Amplex Corp.,** 111 Water St., Brooklyn 1, N. Y.

Circle 815 on page 19

Pressure Transducer

miniature unit has voltage output to 50 v

Model 451218 potentiometer-output pressure transducer is a 1-cu in. unit which weighs less than 3 oz. High-level voltage output to 50 v can be used directly without amplification. Transducer is available in pressure ranges from 0-15 to 0-50 psi, absolute, differential or gage. Pressure capsule actuates, through low-friction 7:1 multiplication mechanism, the brush of a precision potentiometer. Resolution of 0.33 per cent is provided, with linearity tolerance of



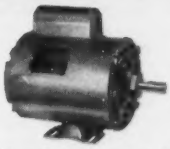
WAGNER ELECTRIC MOTORS...THE CHOICE OF LEADERS IN INDUSTRY

Reduce Down Time—Power your Product with *Dependable* Wagner Motors

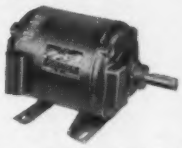
Sixty-six years of experience goes into the building of Wagner Motors. Their reputation for reliability, their electrical characteristics, price and prompt delivery make them a sound choice for your product.

Whatever your motor requirements may be—single-phase or polyphase... ⅙ or 500 horsepower—Wagner can offer a standard motor that is entirely dependable in its specific application. A few of the many motors in the Wagner line are shown below.

FRACTIONAL HP



TYPE RK — Capacitor-start Induction. For general purpose applications. Single-phase. Rigid or resilient mounting. 48 frame: ⅛ or ¼ hp. 56 frame: ⅓ through ¾ hp. Also available in integral ratings through 5 hp.

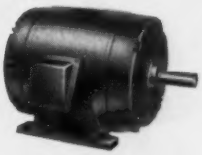


TYPE RA — Repulsion-start Induction. For general purpose applications. Single-phase. High starting torque—low starting current. ⅛ through ¾ hp. Also available in integral ratings through 15 hp.

TYPE RB — Split-phase Induction. For easy starting applications. Single-phase, resilient mounting. 48 frame: ⅛, ¼ or ⅓ hp.

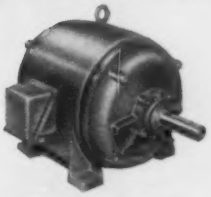
TYPE RP — Polyphase Squirrel-cage Induction. General purpose, normal torque. 56 frame: ¼ through ¾ hp.

INTEGRAL HP

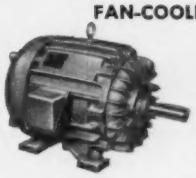


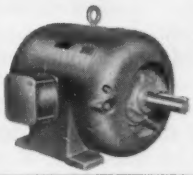
DRIP-PROOF

TYPE DP—Squirrel-cage Induction, corrosion resistant cast iron frames. 1 through 125 horsepower.

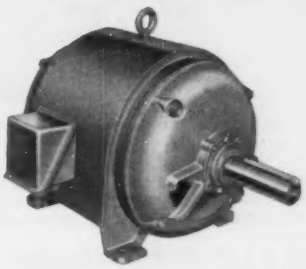


TOTALLY ENCLOSED FAN-COOLED





TYPES EP AND JP Standard and explosion-proof. Squirrel-cage induction, corrosion resistant cast iron ribbed frames, 1 through 30 hp—smooth frames, 40 through 250 hp.



OPEN TYPE POLYPHASE SQUIRREL CAGE

TYPE RP—Drip-proof. Suitable for all general purpose applications. Available in ratings 150 through 500 hp.

OTHER WAGNER MOTORS

In addition to a complete line of standard motors, Wagner also furnishes Increment Type Motor and Starter Combinations... Wound Rotor Polyphase Motors... Jet Pump Motors... Vertical and Flange Mounted Motors... Hermetic Motors... Gear Motors and Direct-Current Motors. Consult the nearest of our 32 branch offices, or mail coupon today for full information on the complete Wagner line.

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SERVING INDUSTRY SINCE 1891

H57-10

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Please send Bulletin MU-185 on your complete line of Motors.

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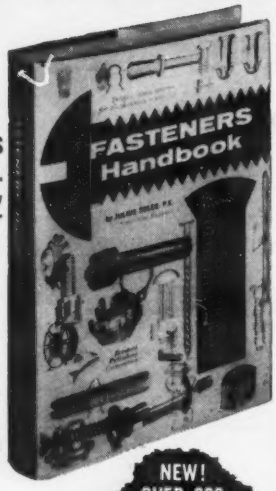
Details, ideas, sources for all fastening needs . . .

FASTENERS Handbook



by JULIUS SOLED, P.E.
Consulting Engineer

1957
448 pages
$12.50

NEW! OVER 900 ILLUSTRATIONS!

FASTENERS HANDBOOK provides ready, up-to-date answers to fastening problems in all fields. Its pertinent data, hundreds of illustrations, and full page descriptions supply you with detailed information on currently available fasteners.

Here is a *handbook* in every sense of the word. You can *select* the fastener you want because this comprehensive book includes standard and proprietary fasteners from all manufacturers.

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- Relates actual uses of fasteners in one industry to those of another, resulting in concrete examples of money-saving applications.

FASTENERS HANDBOOK greatly facilitates the review of available information, the making of a valid selection, and contacting the sources of supply. It can be used by design engineers, patent attorneys, sales personnel, fastener distributors and jobbers—in fact, anyone who needs solid information on fasteners available for mechanical assembly.

Everything in fasteners

Rivets, Inserts, Screws, Bolts, Studs, Nuts, Washers, Retaining Rings, Pins, Nails, Metal Stitching, Quick Release Fasteners, Masonry Anchoring Devices, Hose Clamps, Manufacturers Directory.

Send now for your ON-APPROVAL *copy*

REINHOLD PUBLISHING CORPORATION
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Circle 578 on page 19

Engineering Equipment

less than 1.5 per cent of full-scale output. Mounting is accomplished by flange, stacking, strap mounting, or threaded pressure connector, and unit can be mounted directly at pressure source. **G. M. Giannini & Co. Inc.**, 918 E. Green St., Pasadena 1, Calif.

Circle 816 on page 19

Continuous Printer

utilizes xerographic copying method

XeroX Copyflo Model 2 continuous printer provides, from one or a series of original documents, dry, positive prints up to 11 in. wide at 20 fpm. Reproduction is done by xerography, a fast, dry, electrostatic copying method producing direct, positive, high-quality prints. Process is continuous and automatic, incorporating all necessary steps into one complete cycle. **Haloid Co.**, Dept. PX-266, 2-20 Haloid St., Rochester 3, N. Y.

Circle 817 on page 19

Pressure Gage

has 0.031-psi accuracy

Ded-Ac pressure gage measures all absolute and differential pressures from 0 psi absolute to 600 psi gage with accuracy of 0.031 psi. Scale reads pressure directly in psi and provides a range of ±10 psi at any input level within operating range. Unit functions as

MEEHANITE CASTINGS ARE MADE ONLY BY MEEHANITE FOUNDRIES

The American Laundry Machinery Co., Rochester, N. Y.
Atlas Foundry Co., Detroit, Mich.
Banner Iron Works, St. Louis, Mo.
Barnett Foundry & Machine Co., Irvington, N. J.
Blackmer Pump Co., Grand Rapids, Mich.
Centrifugally Cast Products Div., The Shenango Furnace Co., Dover, Ohio
Compton Foundry, Compton, Calif.
Continental Gin Co., Birmingham, Ala.
The Cooper-Bessemer Corp., Mt. Vernon, Ohio and Grove City, Pa.
Crawford & Doherty Foundry Co., Portland, Ore.
Empire Pattern & Foundry Co., Tulsa, Okla.
Florence Pipe Foundry & Machine Co., Florence, N. J.
Fulton Foundry & Machine Co., Inc., Cleveland, Ohio
General Foundry & Mfg. Co., Flint, Mich.
Georgia Iron Works, Augusta, Ga.
Greenlee Foundry Co., Chicago, Ill.
The Hamilton Foundry & Machine Co., Hamilton, Ohio
Hardinge Company, Inc., New York, N. Y.
Hardinge Manufacturing Co., York, Pa.
Johnstone Foundries, Inc., Grove City, Pa.
Kanawha Manufacturing Co., Charleston, W. Va.
Koehring Co., Milwaukee, Wis.
Lincoln Foundry Corp., Los Angeles, Calif.
Nordberg Mfg. Co., Milwaukee, Wis. and St. Louis, Mo.
Palmyra Foundry Co. Inc., Palmyra, N. J.
The Henry Perkins Co., Bridgewater, Mass.
Pohlman Foundry Co., Inc., Buffalo, N. Y.
The Prescott Co., Menominee, Michigan
Rosedale Foundry & Machine Co., Pittsburgh, Pa.
Ross-Meehan Foundries, Chattanooga, Tenn.
Sonith Industries, Inc., Indianapolis, Ind.
Standard Foundry Co., Worcester, Mass.
The Stearns-Roger Mfg. Co., Denver, Colo.
Valley Iron Works, Inc., St. Paul, Minn.
Vulcan Foundry Co., Oakland, Calif.
Washington Iron Works, Seattle, Wash.
Dorr-Oliver-Long, Ltd., Orillia, Ontario
Hartley Foundry Div., London Concrete Machinery Co., Ltd., Brantford, Ontario
Otis Elevator Co., Ltd., Hamilton, Ontario

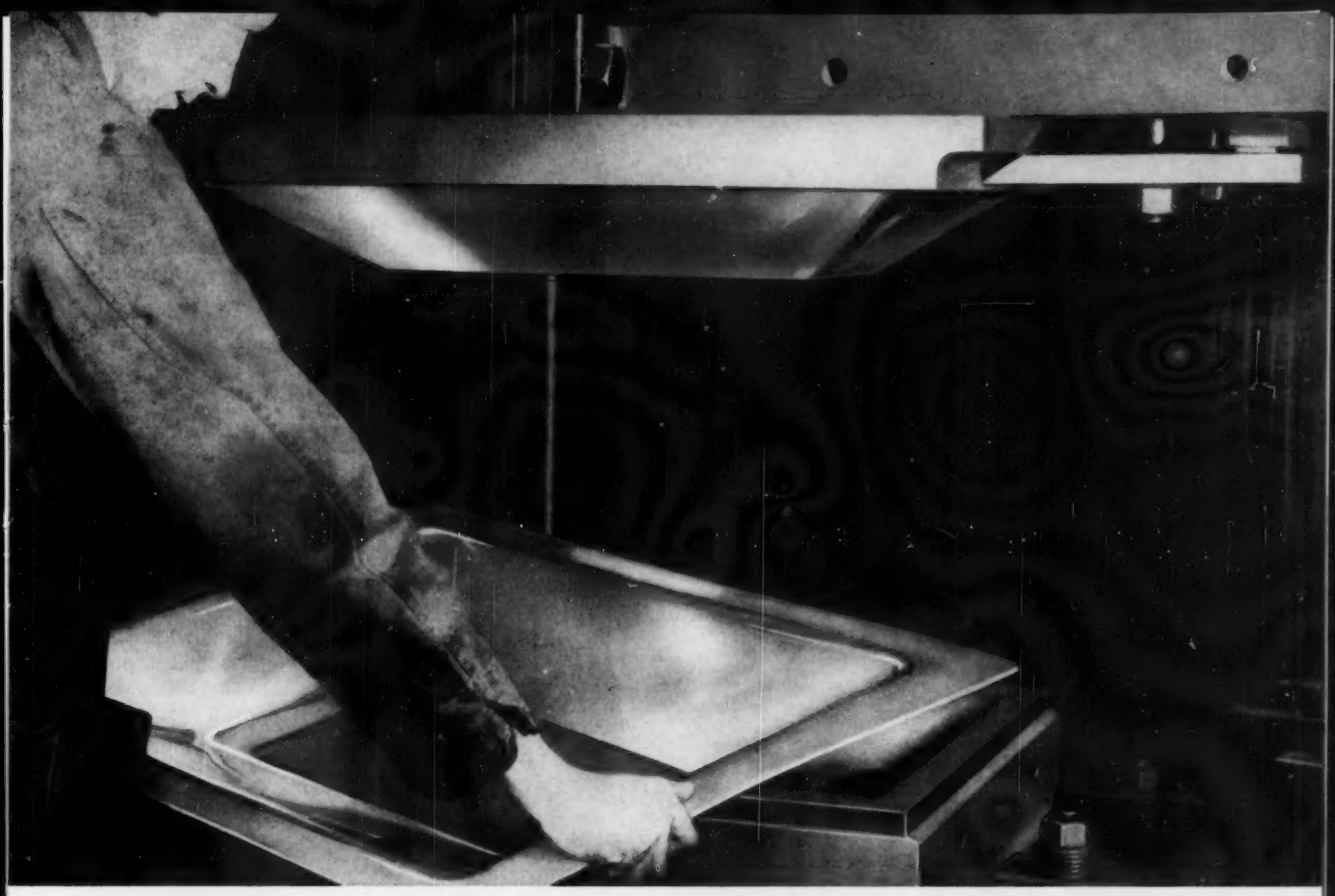
SEND FOR FREE BULLETIN 41 TODAY

Meehanite Metal as a Material for Forming & Stamping dies

Write today to Meehanite Metal Corporation, Department 4D, 714 North Avenue, New Rochelle, New York.

MEEHANITE®

Circle 579 on page 19



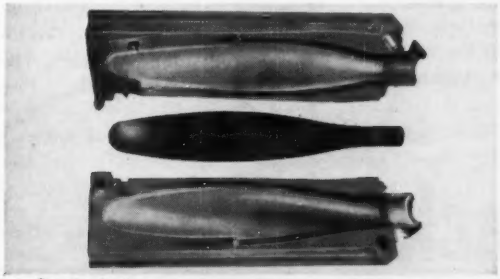
Increase die life and lower production costs with cast-to-form Meehanite metal dies

Longer service life is obtained with Meehanite dies because of their better wear resistance and freedom from galling, scuffing and scoring. Meehanite metal, combining the most desirable properties of gray iron and steel, is one of the most versatile die materials available.

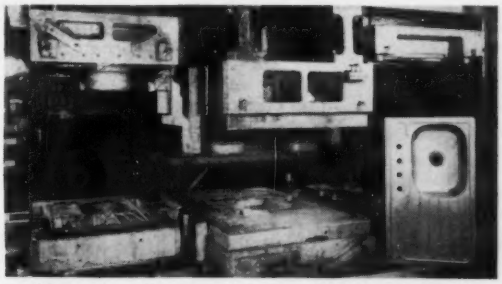
Meehanite dies provide high strength and toughness combined with excellent self-lubricating properties. Dies made in Meehanite metal take on a permanent glass-smooth finish and assure long runs of flawless pressings and shapes. Meehanite dies are used successfully for deep drawing and shaping all steels and non-ferrous alloys.

Substantially lower production costs are achieved by casting large and complicated die parts in one piece rather than building up die assemblies. Machining allowances are held to a minimum and dies may be hardened by local or uniform heat treating without distortion.

For additional information, send for Bulletin No. 41 "Meehanite Metal as a Material for Forming & Stamping Dies."



Steel airplane propeller blades that must be as near perfect as possible are manufactured with Meehanite dies that prevent distortion during quenching after heat treating. The dies shown contain cored passages through which cooling water flows.

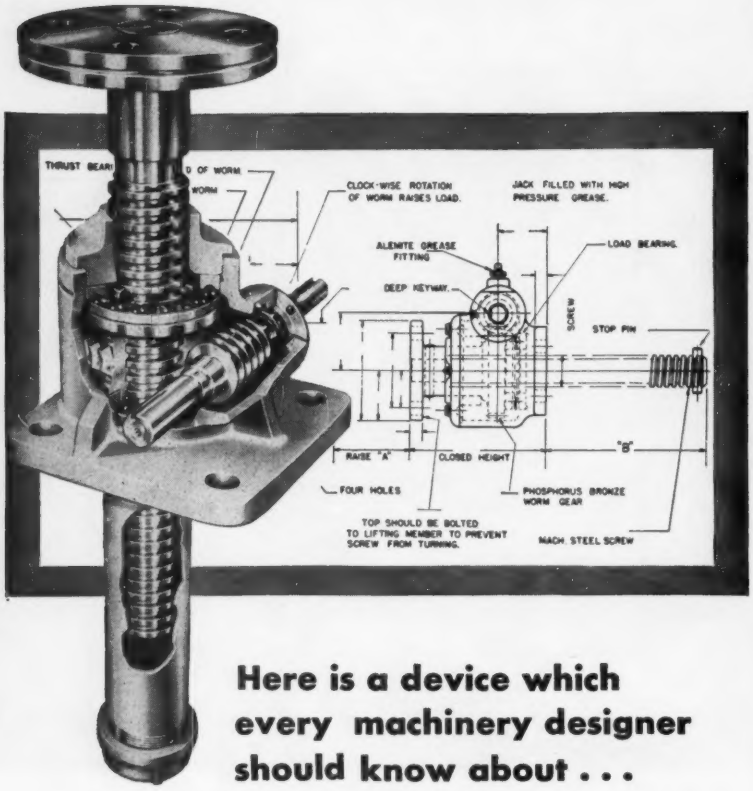


Meehanite dies have been used in drawing and forming operations for over 25 years by the Ingersoll Products Division of Borg-Warner Corporation in the manufacture of stampings for the automotive, farm equipment and home appliance industries.

MEEHANITE BRIDGES THE GAP BETWEEN CAST IRON AND STEEL®

MEEHANITE METAL

MEEHANITE METAL CORPORATION, NEW ROCHELLE, NEW YORK



Here is a device which every machinery designer should know about . . .

DUFF-NORTON WORM GEAR JACKS

Duff-Norton worm gear jacks provide a purely mechanical means for accurate positioning of loads weighing as much as several hundred tons and maintaining them indefinitely without creep. They will operate in any position, and functioning as components of machinery and equipment they can raise and lower loads, apply pressure or resist impact. Jack capacities range from five to 50 tons. When two or more jacks are connected by means of shafting and mitre gear boxes they lift in unison, even when the load is unevenly distributed. They are available with standard raises up to 25 inches, and will provide exactly the same raise for years without adjustment. Worm gear jacks are suitable for operation at ambient temperatures up to 200°F.

Thousands of these jacks are in use on feeding tables, tube mills, welding positioners, pipe cut-off and threading machines, testing equipment, aircraft jigs, loading platforms, rolling mills, conveyor lines, arbor presses, and numerous other types of equipment. If you have a positioning problem, write for complete information, requesting bulletin AD-34-V, which includes drawings and full specifications.

Duff-Norton Jacks

DUFF-NORTON COMPANY

P. O. Box 1889 • Pittsburgh 30, Pennsylvania

COFFING HOIST DIVISION: Danville, Illinois

Ratchet Jacks, Screw Jacks, Hydraulic Jacks, Special Worm Gear Jacks, Ratchet Hoists, Electric Hoists, Load Binders, Spur Gear Hoists

Circle 580 on page 19

Engineering Equipment

a transducer for electrical recording without intermediate amplification, and can be used to calibrate other gages. **Manning, Maxwell & Moore Inc.**, 250 E. Main St., Stratford, Conn.

Circle 818 on page 19

Recording Oscillograph

has eight speeds from 3 to 400 ips

CR1B cathode-ray oscillograph records simultaneously up to 16 input channels at frequencies to 100,000 cps on a single 8-in. wide record. Unit is a complete, high-precision recording system which includes its own power supplies, preamplifiers, deflection amplifiers, and recorder. Precise, drift-free signals are recorded as traces, sharply focused by the optical system and recorded on photographic film

or paper. Eight speeds from 3 to 400 ips can be selected through front-panel pushbuttons. Continuous 400-ft records can be run, or shorter records from 1 to 50 ft long can be taken automatically by means of a preset length selector. Standard commercial film and paper are used. **Consolidated Electrodynamics Corp.**, 300 N. Sierra Madre Villa, Pasadena, Calif.

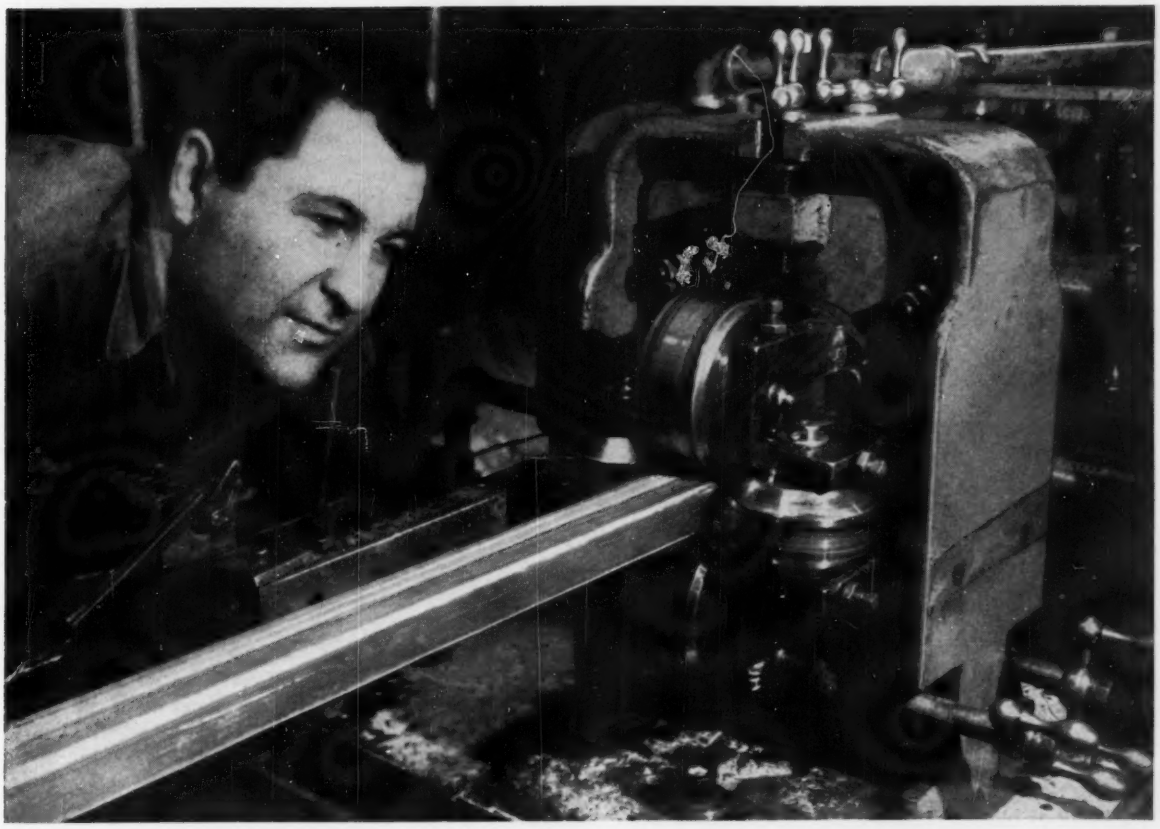
Circle 819 on page 19

Strain Gages

for measurements to 1100 F

Precision high-temperature strain gages are available in standard, rosette, and cross types, for measurements to 1100 F. Strain-sensitive element is Karma wire, nominal resistance is 120 ohms, and gage factor is 2.25. Each unit is

MATERIAL SELECTION



And now — rectangular tubing from Bethcon sheet

The success of round tubing formed from galvanized steel sheet has quite logically led to the development of square, rectangular and even half-round tubing of galvanized steel.

These shapes are turned out on a continuous and compact little rolling mill, using an endless ribbon of Bethcon galvanized sheet. The mill forms the tubing, welds the seam, trims off excess weld metal and shears the finished product to length — all without pausing for breath!

The new tubular shapes are finding a warm reception in such applications as office partitions, bed frames, railings, truck bodies and varied structural applications. Bethcon is an ideal material to use in forming these shapes. It takes severe forming without flaking or peeling of the zinc, and comes through the welding process in excellent shape. Another important point is that Bethcon, galvanized in Bethlehem's continuous lines, is available in coils for smooth operation and production economies.

Bethcon has helped many a manufacturer to turn out new products or improve on old ones. Makers of such widely different items as spiral conduit, metal lath, electrical outlet boxes, air-cooler cabinets, are profiting from the strength, light weight, corrosion-resistance and low cost made possible by the use of Bethcon.

Where you need the strength of steel, tightly coated for corrosion-resistance, you're likely to find the answer in Bethcon sheet steel. One of our representatives will gladly discuss your problem with you. You name the time and place.

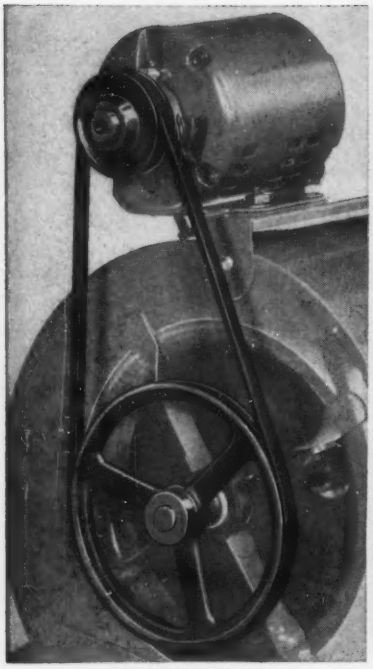
BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

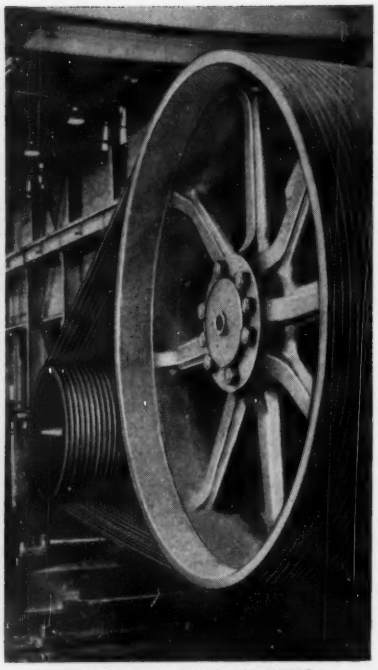
BETHLEHEM STEEL

BETHLEHEM STEEL

Circle 581 on page 19



FHP V-DRIVES



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Circle 582 on page 19

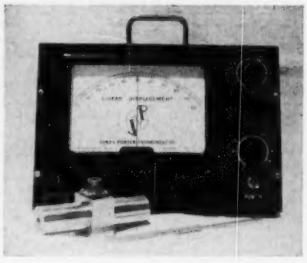
Engineering Equipment

equipped with 6-ft long glass-fiber-covered Nichrome V lead wires. **Columbia Research Laboratories,** Woodlyn, Pa.

Circle 820 on page 19

Transducer

measures linear displacement



Model LD-20 transducer measures linear displacements up to 2 in. and indicates over distances of 1000 ft or more. Unit functions with linear displacement indicator with 60-cycle bridge input, eliminating necessity for an oscillator and amplifier. Transducer and indicator are both temperature compensated. **Jones-Porter Instrument Co. Inc.,** Box 666, Riverdale, N. J.

Circle 821 on page 19

Pencil Pointers

in desk and pocket models

Universal four-way pencil sharpener and pointer is a four-blade, four-action combination. Blade one shaves only wood, saving wood and graphite through automatic stops; blade two sharpens lead to a fine point; blade three sharpens artists' pencils, propelling-pencil leads and press-top pencil leads to 3 mm diam; and blade four accommodates 2 mm diameters. Body holds extra blades of Swedish steel, and transparent top collects shavings. Two-way pocket unit has transparent shavings container and Swedish steel blades. **Alvin & Co.,** Palisado Ave., Windsor, Conn.

Circle 822 on page 19

(Advertisement)

New trends and developments for design engineers...

How Carboloy® cemented carbides' wear-resistance and other unique properties solved three tricky problems

Carbides' low coefficient of thermal expansion keeps tiny parts tiny

The Van Keuren Co., Watertown, Mass., specializes in precision measuring tools, and tiny parts such as bearings and pivots for instruments, components, and missiles.

Dimensions of these parts are often measured in thousandths . . . and their tolerances in millionths.

It's hard enough to *make* anything as small as the pivot shown in Figure 1, but once it's done, making sure it *stays* that size despite ambient temperatures and rugged operating conditions is another problem.

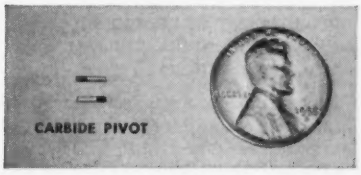


FIG. 1 — Carbide pivots measure .0030" in diameter, .0165" in length.

Carboloy cemented carbides were the perfect solution because they do not expand and contract like other materials. Their coefficient of thermal expansion is less than half that of SAE 1095 heat-treated steel.

For example, from 70° to 1292°F., Carboloy Grade 779 has a coefficient of 2.80 x 10^{-6}/°F. — compared to 8.20 x 10^{-6}/°F. for SAE 1095.

In addition, carbides resist atmospheric corrosion and erosion. They can be lapped and polished to a mirror finish for smooth, accurate bearing action. And they're ideal materials where compressive loads are high because carbides' ultimate limit in compression is 2 to 16 times that of steel.

Carbides' high temperature resistance solves soldering problem for H. & A. Selmer

Soldering clarinet keys in place takes a steady hand with the gas torch, and special jigs for holding and positioning tiny assemblies (Figure 2).

H. & A. Selmer, Inc., leading manufacturer of band instruments had no trouble getting the steady hands. The problem was with the jigs.

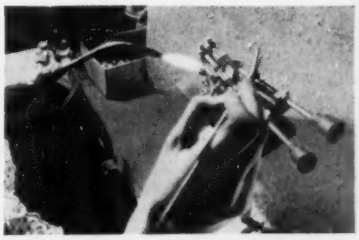


FIG. 2 — Carbide points hold and position clarinet key assembly during soldering.

Because of the high temperatures needed for silver soldering the nickel-silver keys, Selmer was using stainless steel jigs. Unfortunately, the keys often ended up soldered to the jig; as well as to their own parts. This meant hours of hand filing, extra cleaning, frequent repairs of the jigs.

Then Selmer engineers introduced the use of Carboloy cemented carbide location points. In addition to being the hardest metals made by man, they have the ability to resist excessive oxidation at temperatures of 1500° to 1600° F.

And, once carbide is coated with a thin layer of oxide, neither the solder, nor the keys, will stick to the holding and location points.

Soldering operations were speeded up; hand filing eliminated; jigs stayed accurate longer—and Selmer's costs came tumbling down.

Carbide's resistance to corrosion keeps printing ink flowing for IBM

When IBM makes IBM cards, it makes them by the millions. And it makes them on special high-speed machines that automatically print, cut, and count 1600 cards a minute.

Each machine has its own miniature printing press. Ink is metered out by a stainless steel pump submerged in a well in the machine base.

Wear on the pump parts was problem enough. But the ink was also corroding its impeller bushings and shaft.

IBM engineers solved the problem by installing Carboloy cemented carbide bushings and shafts.

Normally, carbides are not used for their corrosion resistance alone.

But, as in cases like this, where a *combination* of corrosion-resistance and wear-resistance is needed, Carboloy cemented carbides can more than pay their own way.

They have good resistance to organic acids, many inorganic acids and bases . . . and are practically inert to attack by salt water spray.

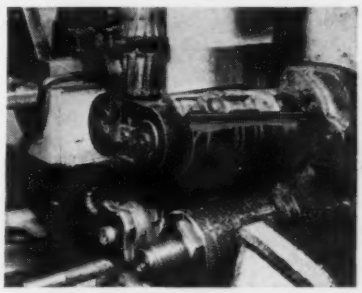


FIG. 3 — Miniature printing press in IBM card machine. Note carbide shearing knives above the printing plate.

Incidentally, IBM is also saving an estimated $40,000 a year in labor costs for regrinding the rotary shear knives used to cut the cards to length.

By changing to Carboloy carbide knives, 267 million cards are trimmed before resharpening — compared to only 16 million with steel knives.

IBM, Selmer, and Van Keuren each used a *different* grade of carbide. Because Carboloy carbides are available in 19 standard grades, they could select the grade with exactly the right characteristics for their particular needs.

If you would like additional technical data on the unique properties of this material—or expert assistance on design problems, write: *Metallurgical Products Department of General Electric Company, 11126 E. 8 Mile Blvd., Detroit 32, Michigan.*

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Circle 583 on page 19

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Circle 584 on page 19

THE ENGINEER'S Library

Recent Books

Essential Strength of Materials. *By Frederick R. Lisarelli, Purdue University;* 261 *pages,* 5½ *by* 8½ *in., clothbound; published by and available from McGraw-Hill Book Co. Inc.,* 330 *West* 42*nd St., New York* 36, *N. Y.;* $4.75 *per copy.*

Theory of strength of materials has been developed in this book with algebra and trigonometry alone. Formulas which cannot be derived without calculus have been assumed. Topics include tables of properties of materials, centroids and moments of inertia, simple stresses, welded joints, calculations of the strength of welded joints, flexure formulas and simple-stress formulas.

Lefax Manual of Mathematics. 334 *pages,* 5 *by* 7 *in., imitation-leather bound; available from Lefax,* 9*th and Sansome Sts., Philadelphia* 7, *Pa.;* $4.25 *per copy.*

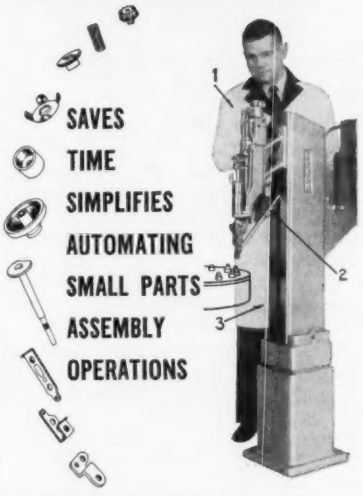
This book contains five major sections which extensively treat elements of algebra, graphic presentation of curve formulas, graphical differentiation and integration, hyperbolic functions, parabolic interpolation, principles of the slide rule, and American Standard mathematical symbols.

Design of Machines. *By Rolland T. Hinkle, Professor of Mechanical Engineering, Michigan State University;* 188 *pages,* 6 *by* 9 *in., clothbound; published by and available from Prentice-Hall Inc.,* 70 *Fifth Ave., New York* 11, *N. Y.;* $4.00 *per copy.*

This book introduces basic concepts of mechanical design relative to new machines. Theories which are frequently used are integrated and presented as a refresher background rather than as individual units for reference.

General topics include optimum design considerations with reference to loading, chain speed, belt

New Standard DIXON *Auto-Positioner*



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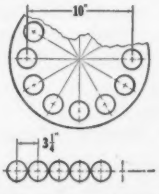

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Circle 585 on page 19

Designer Al Roethlisberger talks plastics

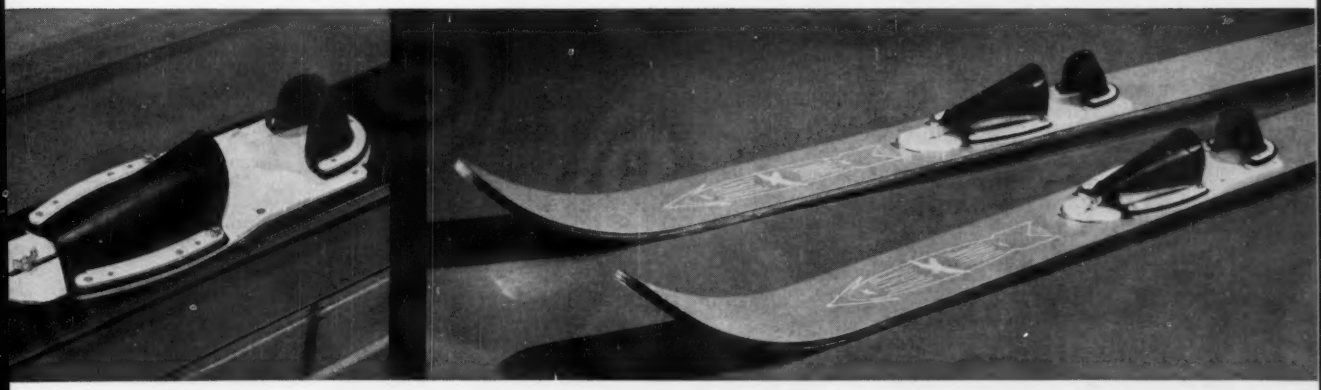
"IN DESIGNING A FOOT BINDER for Cravotta Brothers' Black Hawk water ski, these points were paramount: the binder had to be light, strong, resistant to impact, easily manufactured, and, of course, low in cost. In addition, the binder had to be comfortable and readily adjustable.

"A number of metals and plastics were evaluated and tested. Taking all factors into careful consideration, especially those listed above, we decided on DYLENE® polystyrene—a Koppers plastic—for our base material. When Plastic Molded Parts Co. finished a test model, it was immersed in Great Salt Lake for forty-eight hours. (Salt concentration was 28%—comparable to many months of actual use.) In addition, we had a 4000-pound car towed up a 15° grade with the plastic unit—fastened in its normal way—subject to the entire strain. No failure occurred in these rigid tests of corrosion or stress.

"The six component parts are molded on a 3-minute cycle. The rubber sections you see are riveted in place and the entire assembly bolts to the ski itself in seconds. The finished binder is comfortable to the foot, there are no burrs or rough edges, and the unit can be adjusted while skier is actually in motion.

"I feel that manufacturers of plastics have made excellent progress in product development since the war. As long as they continue this progress and designers and application men use plastics *properly*, the industry can't help but prosper."

Chances are that one of Koppers fine plastics can help *your* product prosper, too. For more information on DYLENE polystyrene, DYLAN® polyethylene, SUPER DYLAN® polyethylene and DYLITE® expandable polystyrene, write to Koppers Company, Inc., Chemical Division, Dept. MD-97, Pittsburgh 19, Pennsylvania.



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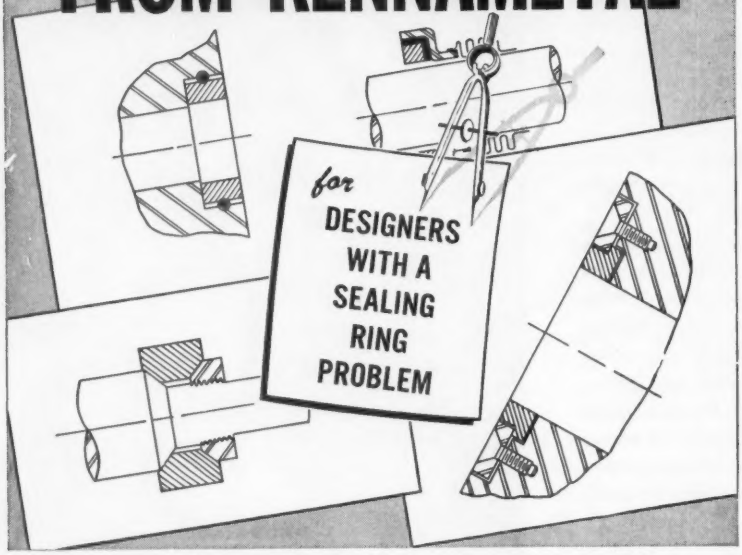
KOPPERS

KOPPERS PLASTICS

Circle 586 on page 19

PERFORMANCE REPORT FROM KENNAMETAL*



If you have any sealing ring problem that demands . . .

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ABRASION RESISTANCE. Kennametal tungsten carbide sealing rings installed in a deep-well rotary pump gave one to two years' service; packing type seals had failed in two to four weeks. Kennametal rings in a recirculating pump, handling water with fine grains of iron oxide, lasted 30 to 60 *days*. Packing type seals failed in 24 to 48 *hours*.

ELEVATED TEMPERATURES. A jet engine shaft seal of Kentanium,* a titanium carbide, operating without lubrication at 15,000 surface feet per minute under 0.3 to 0.6 lbs. pressure per lineal inch of circumference and 900° to 1000° F, outperformed every other material. Kentanium Rings are stress-free—do not tend to split radially, maintain original face flatness even at high temperatures, and have exceptional wear and resistance strength.

SEVERE CORROSION. Where corrosion and abrasion are present, Kennametal has seal rings of Grade K501, a platinum-bonded carbide. Used as seals to confine liquid oxygen or fuming nitric acid, sealing results are reported as "far superior to any previously used materials, with no indication of face wear."

Other desirable characteristics of Kennametal seals: high modulus of elasticity, low expansion under heat, high resistance to wear and much lower service cost. For more information, ask for "Characteristics" book, write KENNAMETAL INC., Latrobe, Pennsylvania, Dept. DM123.

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speed, and speed and size relationships.

Specific topics in machine design include centrifugal couplings, Thrustor brake, gear reducers, and yoke riveter.

Fundamentals of Mechanical Design. *By Richard M. Phelan, Associate Professor of Mechanical Engineering, Cornell University; 526 pages, 6 by 9 in., clothbound; published by McGraw-Hill Book Co. Inc., 330 West 42nd St., New York 36, N. Y.; available from* MACHINE DESIGN *$8.75 postpaid.*

This book presents fundamentals of mechanical design by combining concepts normally covered in the design sequence for mechanical engineers, such as kinematics, mechanisms, dynamics of machinery, and design of machine elements. Major emphasis is placed on what can be done, what principles are involved, and where can be found additional detailed information that may be required in actual design or selection of mechanical elements or a machine.

Coverage is broad, particularly in relation to mechanical components such as couplings, clutches, and variable-speed drives that are often purchased as complete units and incorporated into machines. Only enough handbook information is included to acquaint the designer with types of information available in handbooks and catalogs.

Fundamentals of Electron Devices. *By Karl R. Spangenberg, Stanford University. 505 pages, 6 by 9 in., clothbound; published by McGraw-Hill Book Co. Inc., 330 West 42nd St., New York 36, N. Y.; available from* MACHINE DESIGN, *$10.00 postpaid.*

This book presents a fundamental treatment of electron devices including vacuum tubes and transistors, with emphasis on similar features of both. Internal physics of the devices are stressed, and a fundamental treatment of circuit application is included.

A new approach is represented in the detailed treatment of energy levels in semiconductors and influence of these on junction effects, emission, and photoeffects.

ENGINEERING BULLETIN
ON MICRO-BEARINGS
Miniature Instrument Ball Bearings

NEW HAMPSHIRE BALL BEARINGS, INC.
PETERBOROUGH 1, NEW HAMPSHIRE

Subject: **CONTACT ANGLE**

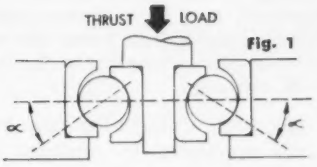

Fig. 1

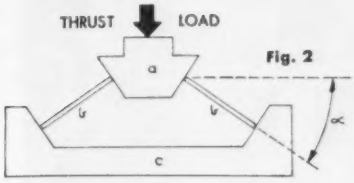

Fig. 2

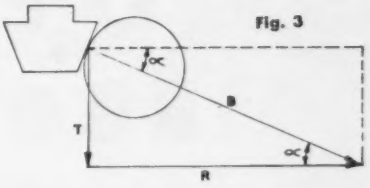

Fig. 3

THRUST LOAD CONSIDERATIONS

Contact angle is the angle between a plane perpendicular to the bearing axis and a line connecting the two points on a given ball where the ball makes contact with the raceways when the bearing is subjected to a pure thrust load. In *Fig. 1*, the contact angle is represented by angle α. The significance of the contact angle is revealed by an examination of the forces present in a thrust loaded bearing.

In *Fig. 2*, a simplified version of *Fig. 1*, the shaft and inner ring combination are represented by the plug *a*, the "working diameters" of the balls are represented by the rodlike members at *b*, and the outer ring is represented by the tapered cup *c*.

The contact angle is α. This diagram represents a three-dimensional structure with as many equally spaced rods, *b*, as there are balls in the bearing.

The primary concern in design is the amount of compressive force to which rod *b* is subject, which is the force with which a given ball is pressed against the raceways. This force can be calculated by constructing a parallelogram of forces as shown in *Fig. 3*.

The sides T and R, are vector quantities, and diagonal B is the vector sum of T and R. Furthermore, the vector sum of the thrust components on all the balls equals the total thrust load on the bearing. The vector sum of the radial components on all the balls is zero. Vector B, the force actually felt by the raceways and balls, compared to vector T, the thrust component, varies significantly with changes in the size of the contact angle and is directly proportional to the thrust load component and inversely proportional to the sine of the contact angle.

Example I:

A bearing is carrying a pure thrust load of 21 pounds. Assuming seven balls in the bearing, each ball will have an axial load component of three pounds, since a thrust load is shared equally by all the balls. While the axial component on each ball is only three pounds, the actual compressive force, or squeeze, felt by the ball and raceways is considerably greater than this value.

With a contact angle of five degrees:

$$B = \frac{T}{\sin \alpha} = \frac{3 \text{ pounds}}{\sin 5^\circ} = 34.5 \text{ pounds}$$

Thus we see that with a five-degree contact angle the actual load felt by each individual ball is actually considerably greater than the total 21 pound thrust load on the bearing.

Example II:

Using the thrust conditions in Example I, the contact angle is increased to 20 degrees, by selecting a bearing with a larger value of radial play.

$$B = \frac{3 \text{ pounds}}{\sin 20^\circ} = 8.78 \text{ pounds}$$

A 15 degree increase in contact angle produced a 74.5% reduction in ball-to-raceway contact stress. This relationship should be noted by anyone who writes bearing specifications. The operational qualities of the bearing, such as low running and starting torque and bearing life, are a function of the ball-to-raceway contact stress. Thus the contact angle is highly significant.

It is not necessary for a bearing user to calculate or specify the contact angle desired. It is only necessary to remember that low values of contact angle are associated with low radial play, and high values of contact angle are associated with high radial play.

While the advantages of large contact angle have been examined above in some detail, there is one important factor which, in high speed applications, places a restriction on the magnitude of contact angle for optimum bearing performance. This is the matter of gyratory forces on the balls. Each ball in a bearing may be visualized as a little planet rotating on an orbit represented by the pitch circle of the bearing, while at the same time rotating about an axis of its own. It is this latter mode of rotation which concerns us at the moment. Every rotating body exhibits gyroscopic characteristics which vary in magnitude with the speed of rotation. Most important of these characteristics is the reaction of the rotating body to changes in the direction of its axis. Now the axis of rotation of a ball in a bearing is represented by a line which passed through the center of the ball and which is perpendicular to the line connecting the points of contact with the raceway. This means that the angle between the axis of ball rotation and the axis of the bearing is equal to the contact angle *(see Fig. 4)*.

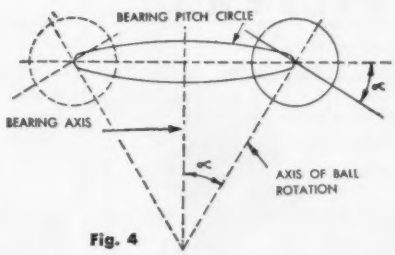

Fig. 4

As the ball travels around its pitch diameter orbit, the axis of ball rotation is forced to change constantly. Specifically, the gyratory moment acting on a ball is proportional to, among other factors, the sine of the contact angle. Thus as the rotational speed is increased, a point will be reached where the gyratory forces acting on the balls will produce slippage between the balls and the raceways. This induces increased operating temperature as well as premature bearing failure.

Thus in high speed applications, optimum bearing performance is a compromise between high contact angle for minimum ball-to-raceway stress, and low contact angle for minimum slippage between balls and raceways.

RADIAL LOAD CONSIDERATIONS

With a pure radial load, the load at any instant is not shared equally by all the balls as in the case of thrust loading, but is supported by three or four balls at most. The higher the radial play, the greater is the tendency for the load to be concentrated on one or two balls; while the lower the radial play, the more the load is apt to be distributed on three or four balls. This more even distribution of load in radially loaded bearings with low radial play is reflected in reduced torque and extended bearing life.

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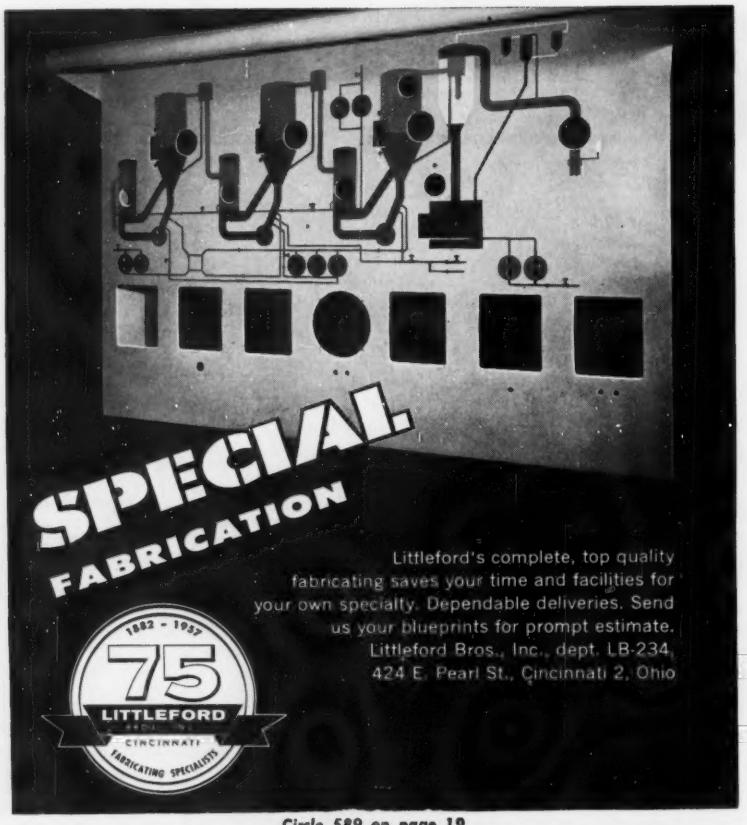
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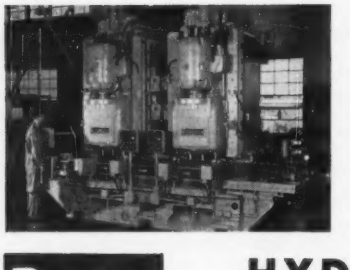

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Lefax Mathematical Tables. *176 pages, 4½ by 7 in., imitation-leather bound; available from Lefax, 9th and Sansome Sts., Philadelphia 7, Pa.;* $3.25 *per copy.*

This book contains formulas and tables applicable to problems in arithmetic, geometry, algebra, trigonometry, analytic geometry and calculus.

Six tabbed indexed sections include mathematical reviews of basic rules, series, equations and theories; area, square and cube tables; logarithms of numbers and proportional parts; logarithms of trigonometric functions; natural trigonometric and hyperbolic functions.

Conversion Tables. *By M. Stand; 10 pages, 5½ by 8½ in., paperbound; available from M. Stand, 527 Lexington Ave., New York 17, N. Y.;* $1.00 *per copy.*

These tables permit conversion of units of length, weight, and volume from the U. S. system to the metric system and vice versa without calculations.

New Standards

Standard Metallizing Symbols (Tentative). *7 pages, 6 by 9 in., paperbound; available from American Welding Society, 33 West 39th St., New York 18, N. Y.;* $1.00 *per copy.*

This booklet provides details for developing metallizing symbols to specify all operations, i.e., surface preparation, extent of metallizing, coating thickness and method of finishing. Examples are included to illustrate use of symbols.

Association Publications

Automatic Coding Monograph, No. 3. *118 pages, 6½ by 9½ in., paperbound; available from the Franklin Institute, Philadelphia, Pa.;* $3.00 *per copy.*

This book contains proceedings of the symposium held at the Franklin Institute, January, 1957.

Circle 590 on page 19

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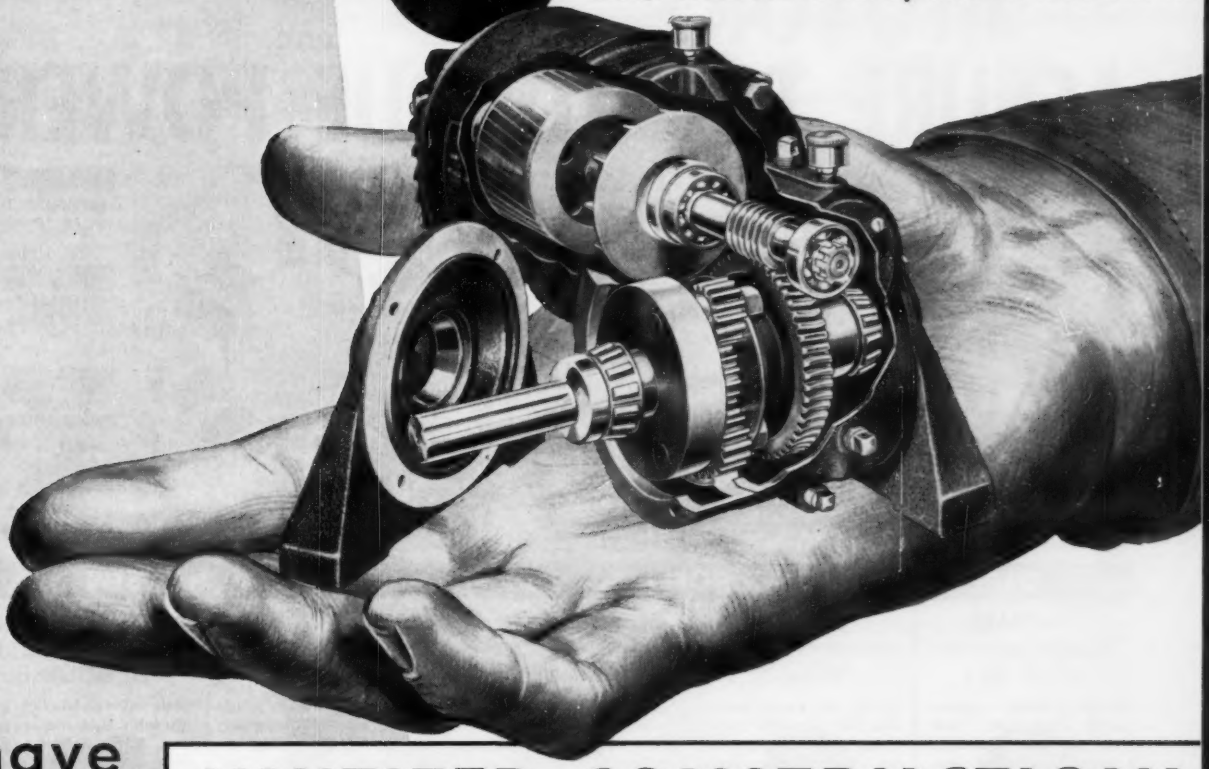

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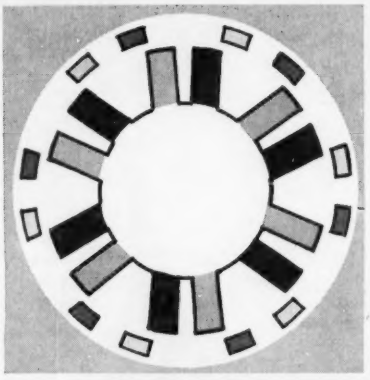

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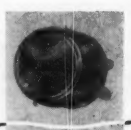

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Topics presented include systems of debugging automatic coding, procedure translation, common language programming system, mathematical language compiler and mechanized coding.

Steel Products Manual, Wire and Rods, Carbon Steel Section. *118 pages, 8½ by 11 in., paperbound; published by and available on letterhead request from American Iron and Steel Institute, 150 East 42nd St., New York 17, N. Y.; additional sections 25 cents per copy.*

This manual section is a combination of former sections 15 and 16. Major topics include chemical ranges and limits for wire rods, methods of manufacture, coarse and fine manufacturers' wire, wire evaluation, and gage tables.

Graphical Design Procedure for Bolted-Flange Connections Meeting ASME Code Requirements. *33 pages, 8½ by 11 in., paperbound; published by and available from Manufacturing Chemists' Association Inc., 1625 Eye St., N. W., Washington 6, D. C., $1.25 per copy.*

This manual presents data which permits rapid selection of lap flanges for a given set of working conditions.

Included are lists of symbols, step-by-step use of design procedures in block-diagram form, and comments on design procedure and exploration of graph use.

Design of Die Castings. *By Gustav Lieby, Translated by Dr. Hubert Altwicker and Elmar Altwicker; 199 pages, 6 by 9 in., paperbound; published by American Foundrymen's Society, Golf and Wolf Roads, Des laines, Ill., $8.00 per copy.*

This book is a translation of the German book by Gustav Lieby and presents information on castings produced by the hot or cold-chamber process.

Numerical values are converted from the metric system. A bibliography of references on die casting and ASTM specifications for alloys are appended to the translation.

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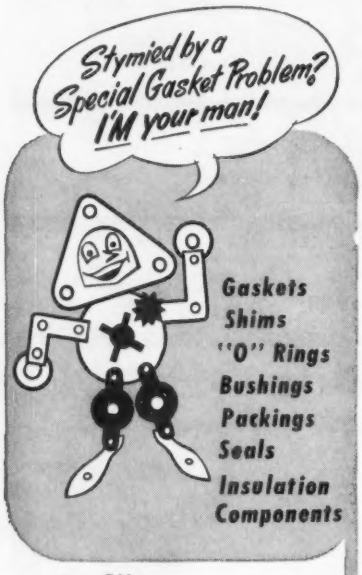

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Circle 594 on page 19

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cast products, die-casting materials and applications, and suggestions for die design and construction methods.

Proceedings of the RETMA Symposium on Applied Reliability. 105 *pages and* 46 *page supplement,* 8½ *by* 11 *in., paperbound; published by and available from Engineering Publishers, GPO Box* 1151, *New York* 1, *N. Y.;* $5.00 *per copy.*

The proceedings contain 14 papers presented at the Radio-Electronics-Television Manufacturers Association Symposium on Applied Reliability held in Los Angeles, December, 1956. Major sections are mechanical reliability, feedback, and component evaluation.

Also included is a supplement on technical reporting of electronic systems reliability measurements.

Investment Casting Engineering and Design Manual. 50 *pages,* 8½ *by* 11 *in., paperbound; published by and available from Investment Casting Institute,* 27 *East Monroe St., Chicago* 3, *Ill.;* $5.00 *per copy.*

This manual presents advantages and limitations of the investment casting process, design rules, dimensional tolerances and shapes, surface finish, parallel sections, blind and through-going cores, threads and airfoil contours.

Also included are the lost pattern and frozen mercury phases of the process, case histories, metal specifications and test standards.

Steel Products Manual, Carbon Steel: Semifinished for Forging; Hot Rolled and Cold Finished Bars; Hot Rolled Deformed Concrete Reinforcing Bars. 64 *pages,* 8½ *by* 11 *in., paperbound; published by and available on letterhead request from American Iron and Steel Institute,* 150 *East* 42*nd St., New York* 17, *N. Y.; additional sections* 25 *cents per copy.*

This section of the Steel Products Manual contains metallurgical aspects, manufacturing practices and descriptions which generally apply to semifinished carbon steel products.

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Proceedings of the National Electronics Conference, Vol. 12. 1095 *pages, 6 by 9 in., clothbound; published by and available from National Electronics Conference, 84 East Randolph St., Chicago 1, Ill.;* $5.00 *per copy.*

This volume contains proceedings of the National Electronics Conference held in Chicago in October, 1956.

Major topics include components and materials, instrumentation, servomechanisms applications, receiver techniques, magnetic amplifiers, solid-state devices, high-power audio systems, and antennas.

Steel Products Manual, Stainless and Heat Resisting Steels Section. 90 *pages, 8½ by 11 in., paperbound; published by and available on letterhead request from American Iron and Steel Institute,* 150 *East* 42nd *St., New York* 17, *N. Y.; additional sections* 25 *cents per copy.*

This section of the Steel Products Manual deals with tolerances, methods of inspection, sampling and chemical analysis, definitions of terms, and other subjects related to stainless and heat-resisting steels.

Major topics include classification of products by size, shape and finish; mechanical properties of plates, hot and cold-rolled sheets and cold-rolled strip; wire and its methods of manufacture; and applications.

Proceedings of the National Conference on Industrial Hydraulics, 12th Annual Meeting. 274 *pages, 6 by 9 in., clothbound; published by and available from Illinois Institute of Technology, Office of the Secretary, Chicago* 16, *Ill.;* $5.00 *per copy.*

This book contains illustrations and text of papers presented at the 12th Annual Meeting of NCIH, October, 1956.

Major sections include papers on nuclear reactors, pumps, components and accessories, pneumatics, servomechanisms and systems, mo-

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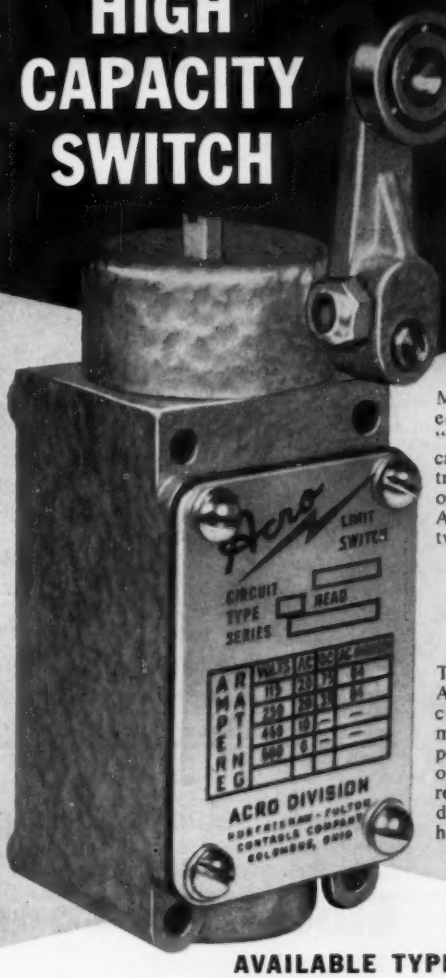

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National Industrial Research Conference Proceedings. 57 *pages,* 8½ *by* 11 *in., paperbound; available from Mrs. Alice Jones, NIRC—2, Armour Research Foundation,* 10 *West* 35th *St., Chicago* 16, *Ill.;* $6.00 *per copy.*

The proceedings include twelve papers presented at the NIRC in Chicago, April, 1957. Major topics include sales and research, manpower, efficiency, research objectives and management in research.

Electronics in Action, Special Report No. 22. 156 *pages,* 6 *by* 9 *in., paperbound; published by and available from American Management Association Inc.,* 1515 *Broadway, New York* 36, *N. Y.;* $3.75 *per copy.*

This report is based on material presented at the Third Annual Electronics Conference and Exhibit in New York in February, 1957.

Representatives of companies having well-established electronic data processing programs describe latest development in all areas of EDP. Included are feasibility studies, installation, selection and training of personnel, application, and evaluation of the system.

Manufacturers' Publications

The Isotope Index. 99 *pages,* 6 *by* 9 *in., paperbound; published by and available from Scientific Equipment Co.,* 23 *N. Hawthorne Lane, Indianapolis* 19, *Indiana;* $3.00 *per copy.*

This book is a collection of data on all commercially available isotopes from world suppliers. Included in the listing of 697 different labeled compounds are supplier information, price per mc and delivery comments. Revised AEC radioisotope licensing procedures are also included.

Handbook of Linear Transducers. 32 *pages,* 8½ *by* 11 *in., plastic bound; available from Automatic Timing Controls Inc., King of Prussia, Pa.;* $2.00 *per copy.*

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Government Publications

Survey of Low-Alloy Aircraft Steels Heat Treated to High-Strength Levels, Part 3—Failure Cases, PB 121667. *By George Sachs, Syracuse University; 72 pages, 8 by 10½ in., paperbound; available from Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.; $2.00 per copy.*

Part 3 of this report presents descriptions of actual failures in high-strength steel. It describes experiments performed for purposes of analyzing failure conditions and determining source failure.

Survey of Low-Alloy Aircraft Steels Heat Treated to High-Strength Levels, Part 4—High Strength Steels and Their General Static Properties, PB 121504. *By G. Sachs and E. P. Klier, Syracuse University; 136 pages, 8 by 10½ in., paperbound; available from Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.; $3.75 per copy.*

This volume discusses factors considered in selecting high-strength steels and assemblies, available information on effects of numerous variables encountered in making, shaping, and heat treating low-alloy steels, and their significance for strength properties of various parts.

NACA Technical Series. *Each publication is 8 by 10½ in., paperbound; copies available from National Advisory Committee for Aeronautics, 1924 F St., N.W., Washington 25, D.C.*

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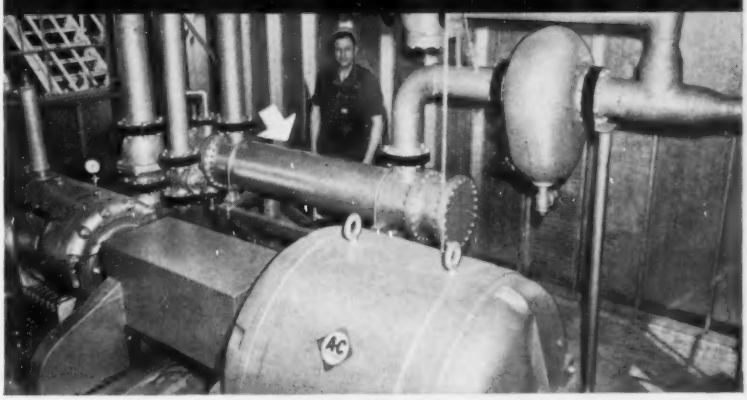

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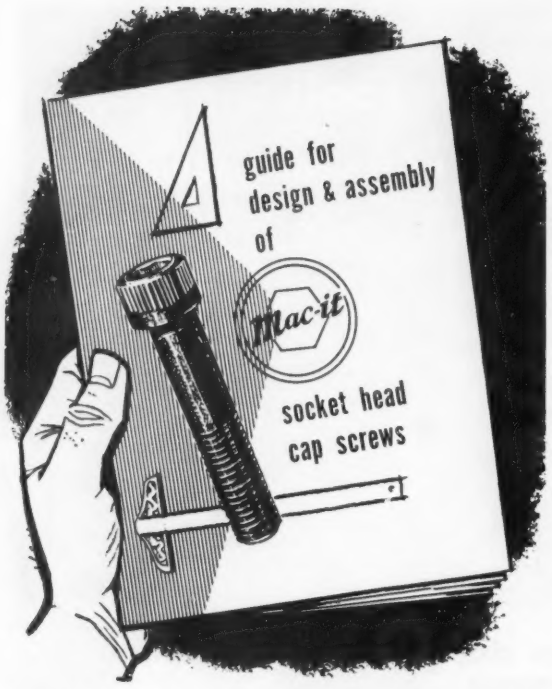

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Every design engineer, draftsman and production supervisor should have a copy. You can get yours from your local Mac-it distributor or write: Mac-it Screw Division, Strong, Carlisle & Hammond, 1392 W. 3rd Street, Cleveland 13, Ohio.

That same distributor also maintains complete, local stocks of
America's first and finest alloy steel screws

Socket Head Cap Screws • Button Head Socket Cap Screws • Flat Head Socket Cap Screws • Hollow Set Screws • Hollow Lock Screws • Hollow Pipe Plugs • Socket Shoulder Screws • Hexagon Head Cap Screws • Square Head Set Screws • Tool Post Screws • Square Head Collar Cap Screws • Slotted Headless Set Screws • Hex Socket Keys

MAC-IT hex socket alloy cap & set **SCREWS**

Stress Relief

DEVELOPMENT of a new product is a unique process—almost by definition. But certain elements are common, such as the exercise of human foibles in the creative process as the project moves from proposal to production. Here, by an engineer who wishes to remain anonymous, is an account calculated to find sympathetic and understanding readers among development and design engineers.

Brake Design Made Simple

Aircraft brake design seems to be a mystery to some people associated with the industry. They have no idea why a multiple-disc brake is used for one type of airplane and a single-disc brake for another type. They probably wonder why a certain disc material is selected and why the linings are arranged as they are. In fact, in some cases they have even wondered why the brake was even built.

Results of interviews of a number of experienced designers are combined into the following discussion, which covers high points in the life of an average aircraft brake in its journey from the drafting board to the field.

Since his favorite layout draftsman is busy on another project, the designer finds that he will have to use an inexperienced man and do all the calculations himself.

The designer calls for a lining area of 3 sq in. per lining. The draftsman misreads the instruction and lays out the brake with linings 3 in. in diameter.

The brake was originally laid out as a single disc type. The airframe manufacturer has just employed a new chief of the landing gear section who prefers two-disc brakes. The design is changed to two discs.

The sales department sends in word that light weight is essential in all new brakes, and brakes must be designed primarily for light weight. Design is altered to suit.

The disc material selected is produced by the chief engineer's golfing partner. The designer asks how he can turn out a good brake when he has to use discs of that material. The chief engineer's golf game gets poorer, and his partner beats him regularly. The designer is ordered to shift to the best disc material available from another company. The designer again asks how he can turn out a good brake with discs of that material.

Management issues a statement that the watchword is economy and that all new designs should have economy of construction and operation as their major criteria. Design is altered to suit.

The designer learns that the Whoosis Brake Co. is laying out a competing multiple-disc brake. He immediately scraps his design and starts over again

on a multiple-disc design. Simultaneously, the designer for the Whoosis Brake Co. has scrapped his drawings and starts a new layout using three discs after hearing that the Whatsis Brake Co. is proceeding on that basis.

The head of the sales department returns from an extended business trip, during which he observed that the present trend is toward higher torque and that all other features, including weight and economy, should be compromised to obtain higher torque. Design is altered to suit.

Development department manager sends in word that the crying need of this country today is a good five-cent cigar. Design is altered to suit.

The experimental shop builds the brake housing an inch too long. To repay the shop for having covered up one of his previous errors, the designer writes a long treatise to the chief engineer pointing out that longer housings permit adding another disc, thus following the trend toward higher torque.

The chief engineer does not grasp the full meaning of the designer's calculation, and he issues an order to have the housing shortened by 1 inch. The designer and shop superintendent talk it over and decide to cut 1 inch off the housing and say nothing more about it.

Material for discs finally arrives, but is $\frac{3}{8}$ in. thick instead of $\frac{5}{8}$ in. as specified. Long correspondence ensues between brake company and disc material company to determine time required to obtain material of specified thickness. Time required is too great, so the design is changed to include an extra disc.

Airframe manufacturer decides to use anti-skid device on airplane, and hydraulic lines must be kept out of the axle. Design is altered to suit.

The brake is tested on the dynamometer and is found to produce torque 5 per cent higher than the designer expected, but 5 per cent less than he showed in his calculations. The torque is 10 per cent more than the chief engineer expected and 10 per cent less than he promised the sales department. The torque is 15 per cent more than the sales department expected and 15 per cent less than that in the original proposal.

Knowing his organization thoroughly, the development department manager finds the torque is exactly what he anticipated.

They Say . . .

"Mature design is that which yields successful operation of an equipment without loss or waste and at minimum cost to the customer for the utility received. Design maturity is measured by dividing the sum of the original, operating, and maintenance expenses by the useful life of the equipment. Dimensionally, this is expressed in cost per unit time. Mature design is reached when this cost has been reduced to a minimum for a given performance output."—RICHARD R. LANDERS, *General Electric Co., Syracuse, N. Y.*

The Lepel line of induction heating equipment represents the most advanced thought in the field of electronics as well as the most practical and efficient source of heat yet developed for industrial heating.

If you are interested in induction heating you are invited to send samples of the work with specifications. Our engineers will process and return the completed job with full data and recommendations without any cost or obligations.

TYPICAL INDUCTION HEATING APPLICATIONS

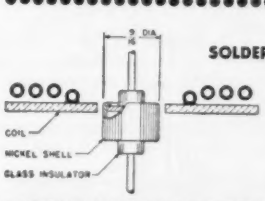
HARDENING DIESEL FUEL INJECTOR

Restriction of heat to end of holder body for fuel injector permits hardening of face to provide required resistance to deformation without hardening the threads. Coil design shown provides uniform temperature for hardening despite holes in face.

REMOVING RUBBER FROM STEEL

Induction heating develops uniform temperature at steel-rubber interface destroying bond for easy separation. Steel and rubber may similarly be salvaged from mounting brackets, shock absorbers, etc.

SOLDERING TRANSISTOR ASSEMBLIES



Concentrator-type coil creates high intensity, restricted heating at joint of nickel shell and tinned glass, thus causing solder flow for permanent seal.

Electronic Tube Generators from 1 kw to 100 kw.
Spark Gap Converters from 2 kw to 30 kw.

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Circle 598 on page 19

LEAKPROOF (SHEAR-SEAL)

$75.00
List Price* for a ½" 4-way incl. Solenoid

*3-way, shut-off and smaller sizes are comparably less. All prices less the usual trade and quantity discounts.

SOLENOID OIL VALVES (250 P.S.I.)

WHERE	WHY	HOW
Thread rolling machines	Holding position (leakproof)	Lapped sealing surfaces seal tight indefinitely as a result of wear compensation
Pressure testing in automotive production	Oil gets contaminated by scale in castings (not critical to dirt) reduced maintenance	Sealing surfaces in constant, intimate contact, dirt can't lock valving members – saves coil burn-out
Hydraulic work feed apparatus	(Leakproof) ... as versus spool valves which cause over-demand on hydraulic system	Positive shut off of internal port to port leakage and of course, no external leakage
Machine tool chucking & clamping	Maintaining safe holding pressure (leakproof)	Saving auxiliary equipment such as pilot operated check valves
Automatic door openers	Quick action (high flow capacity)	No spools or poppets obstructing full, round flow passages
Solenoid controlled hydraulic system on machine you build	Better performance Lower manufacturing costs Reduce service problems	Shear-Seal valves have full flow, are leakproof, not sensitive to dirt Low priced, less auxiliary equipment and labor cost. Valves don't stick, saving coil burn-out; stay leakproof indefinitely, seals are wear compensating

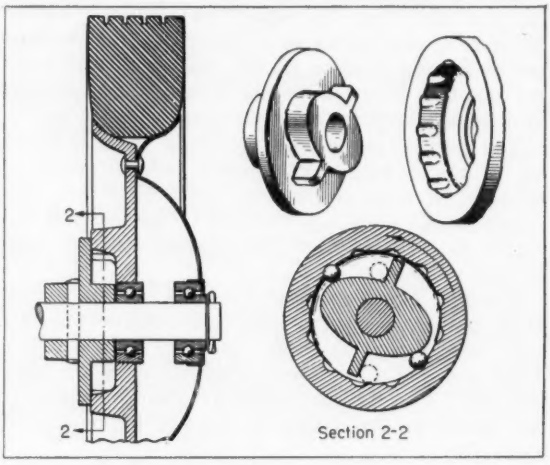
BARKSDALE VALVES

5125 Alcoa Avenue, Los Angeles 58, California
Ask for bulletin 5S-H

Noteworthy

Ratchet Mechanism

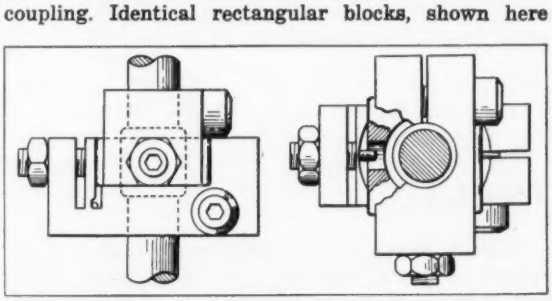
Rollers wedge into notches to couple input and output members of a ratchet mechanism with reversible parts. Wedging action occurs with clockwise rotation of an elliptically shaped rotor in the unit illustrated.



Driving and driven elements are uncoupled when the rotor turns counterclockwise. Disposition of the rollers in the chambers can be easily changed to permit positive drive in either direction. Ratchet application shown here permits free rotation of a wheel on its axle in one direction, interconnects wheel and axle when rotation is in opposite direction. *Patent* 2,800,987 *assigned to Durite Corp. by Harry A. Potts.*

Shaft Coupling

Coaxial shafts with slight misalignment are connected with zero backlash by a three-piece mechanical coupling. Identical rectangular blocks, shown here



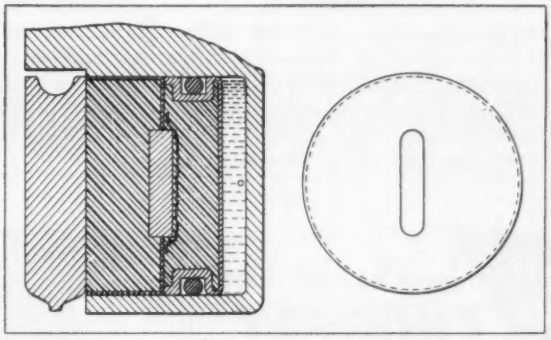
oriented at right angles, are slotted at their ends to permit clamping to driving and driven shafts. Third element of the coupling, a parallel-face square block, seats in saddles in the rectangular driving and driven members. Clearance between elements is taken up by set-screw and leaf-spring adjustments, the springs being formed by undercut slots milled in each

Patents

of the rectangular blocks. Axial misalignment of driving and driven shafts is accommodated by sliding of the coupling block in its saddles. *Patent* 2,801,531 *assigned to International Telephone and Telegraph Corp. by Earle J. Hasney.*

Heat-Insulated Brake Shoe

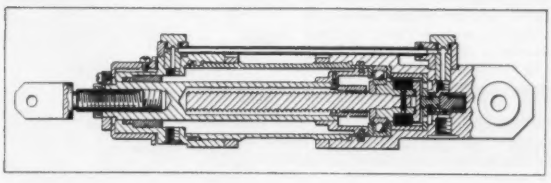
Transmission of braking heat to the hydraulic fluid in a disc-brake assembly is minimized by a heat-insulated friction shoe. Shoe, which is metal-impregnated asbestos, is jacketed on all but the wearing face by thin synthetic rubber with low thermal conductivity. Shoe and piston are coupled by a steel key



embedded in the back of the shoe. Piston constitutes an aluminum-encased plastic of characteristics similar to those of the wearing shoe. During braking, the synthetic-shoe jacket minimizes transfer of braking heat to the cylinder wall, and the plastic piston body provides additional thermal insulation to prevent overheating of the brake fluid. *Patent* 2,801,714 *assigned to Meadville Research Products Corp. by John Dotto.*

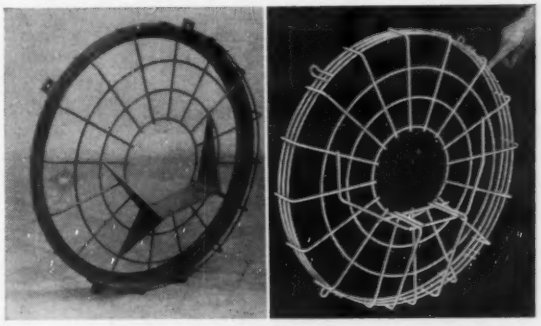
Friction-Locking Actuator

Until system pressure is applied, movement of the piston in a hydraulic actuator is prevented by a multiple-disc brake. Translation of the piston rod is converted to rotary motion at the brake by a conventional ball-screw arrangement. Brake, which is spring loaded "on", is released when fluid pressure is applied to either end of the cylinder. Time required for engagement of the brake is extremely short, allowing

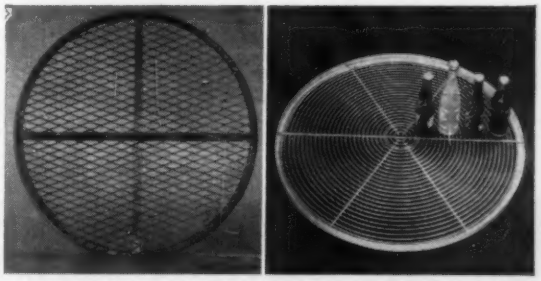


COST CUTTING IDEAS

. . . . by TITCHENER



SAVES $7.15 PER UNIT! Motor mount and guard (left), formerly used by famous electrical equipment manufacturer, required a heavy cast frame, and it weighed 24 lbs. Working with customer's engineers, Titchener designed and built simple wire mount and guard (right). Wire unit weighs only 13½ lbs., improves performance and costs less. For details, circle Report No. 2.



SUPPORTS 200 LBS.! Spiral wire shelf (right) was designed and built by Titchener for beverage cooler manufacturer. Wire shelf is less expensive than expanded metal shelf, supports 200 lbs. without reinforcing. Circle Report No. 1.

Tell it To Titchener Learn how a wire/strip assembly can help you cut costs, ease material shortages and improve your product. Visit our plant and talk to our wire/strip experts. Or send drawings, photographs or samples. We'll send you our suggestions—no cost or obligation.

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E. H. TITCHENER & CO.

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67 Clinton St., Binghamton, N.Y.

Send Wire/Strip Application Reports circled: Nos. 1 2

☐ Have a Titchener Field Engineer call.

NAME TITLE

COMPANY

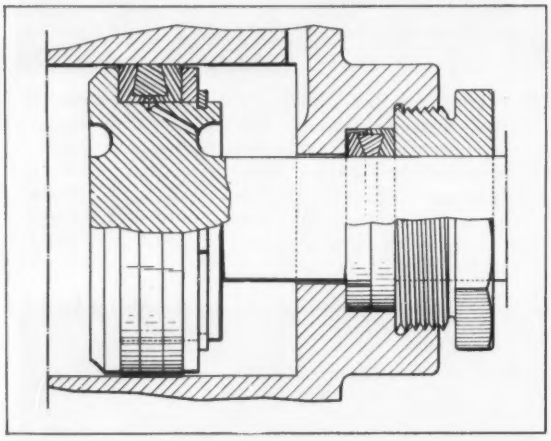
STREET

CITY STATE

actuator to be applied where accurate control of the load is required. *Patent* 2,801,615 *assigned to General Motors Corp. by Howard M. Geyer.*

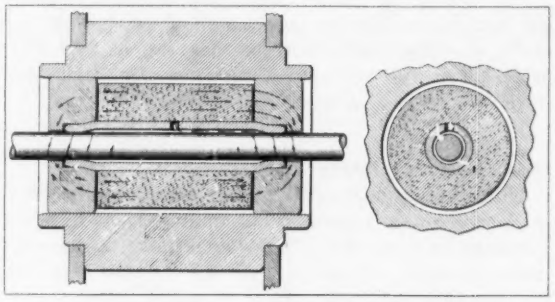
Pressure-Actuated Seal

Sealing action of a pressure-actuated radial seal is substantially independent of the resiliency of the synthetic seal elements. Pressurized fluid, which is ported to an annulus in the seal groove, forces the principal member radially into contact with the piston or rod surface. Because resiliency of the seal members is not a factor, the design can be used with a wide range of synthetic sealing materials, providing any desired degree of chemical inertness and physical stability. *Patent* 2,799,523 *assigned to Linear Inc. by Elliot J. Parker.*

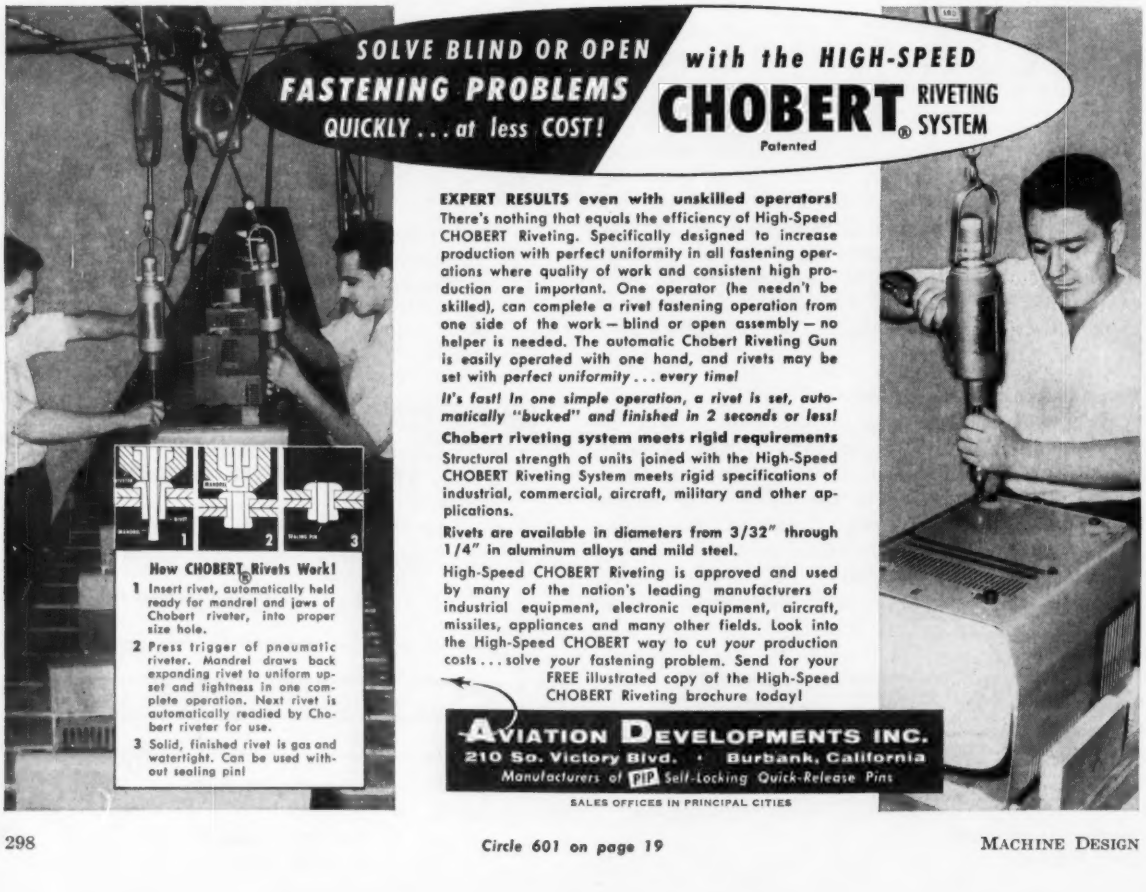


Self-Lubricating Bearing

Controlled and long-lasting flow of lubricant to a bearing is provided by an assembly combining bearing and lubricant distributor in a packaged unit.



Flow of lubricant (shown by arrows) is from the reservoir wick, through the sintered end blocks to the shaft bearings. Lubricant returns to the reservoir through a port at the center of the bearing sleeve. Typical application is in miniature electric motors used to drive clocks or other timing devices. *Patent* 2,800,373 *assigned to Sessions Clock Co. by Stanley J. Kablick and Earl D. Brightman.*


SOLVE BLIND OR OPEN
FASTENING PROBLEMS
QUICKLY . . . at less COST!
with the HIGH-SPEED
CHOBERT® RIVETING SYSTEM
Patented
How CHOBERT® Rivets Work!
1 Insert rivet, automatically held ready for mandrel and jaws of Chobert riveter, into proper size hole.
2 Press trigger of pneumatic riveter. Mandrel draws back expanding rivet to uniform upset and tightness in one complete operation. Next rivet is automatically readied by Chobert riveter for use.
3 Solid, finished rivet is gas and watertight. Can be used without sealing pin!
EXPERT RESULTS even with unskilled operators!
There's nothing that equals the efficiency of High-Speed CHOBERT Riveting. Specifically designed to increase production with perfect uniformity in all fastening operations where quality of work and consistent high production are important. One operator (he needn't be skilled), can complete a rivet fastening operation from one side of the work — blind or open assembly — no helper is needed. The automatic Chobert Riveting Gun is easily operated with one hand, and rivets may be set with perfect uniformity . . . every time!
It's fast! In one simple operation, a rivet is set, automatically "bucked" and finished in 2 seconds or less!
Chobert riveting system meets rigid requirements
Structural strength of units joined with the High-Speed CHOBERT Riveting System meets rigid specifications of industrial, commercial, aircraft, military and other applications.
Rivets are available in diameters from 3/32" through 1/4" in aluminum alloys and mild steel.
High-Speed CHOBERT Riveting is approved and used by many of the nation's leading manufacturers of industrial equipment, electronic equipment, aircraft, missiles, appliances and many other fields. Look into the High-Speed CHOBERT way to cut your production costs . . . solve your fastening problem. Send for your FREE illustrated copy of the High-Speed CHOBERT Riveting brochure today!
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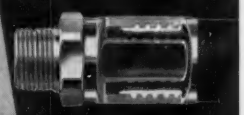
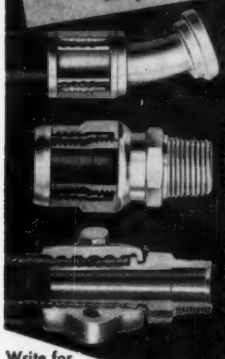
HOSE ASSEMBLIES
Meet Your Most Rigid Requirements





The "inside story" refers first to the cross-sections shown from which the advantages of Anchor Hydraulic Hose Assemblies can be learned.

But, beyond these obvious benefits, we refer to the intangible advantages evolving from the years of experience in production of hydraulic hose assemblies—advantages that show up only in bonus months of dependable service.

Anchor Hydraulic Hose Assemblies are made for high, medium and low pressure service and for use on virtually any equipment using a hydraulic system. Working pressures range from 100 PSI (2" I.D. Spiral Wire Hose) to 7000 PSI ($^3/_{16}$" I.D. 3 Wire Braid Hose) and a variety of coupling styles are available.

Write for Anchor Catalog No. 575 with specifications on Anchor's very complete line of hose assemblies.

ANCHOR COUPLING CO. INC.

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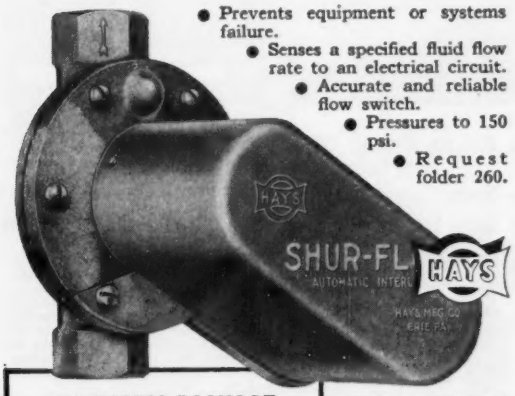
Branch Offices: Dallas, Tex., Plymouth, Mich.

Circle 602 on page 19

Automatic INSURANCE POLICY

HAYS "SHUR-FLO" INTERLOCK
FOR WATER, AIR OR LIGHT OIL



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- Senses a specified fluid flow rate to an electrical circuit.
- Accurate and reliable flow switch.
- Pressures to 150 psi.
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TRUE, ACCURATE WAY TO OBTAIN SPECIFIC FLOW RATE REGARDLESS OF PRESSURE. REQUEST FOLDER 231

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FLEXIBLE GEAR COUPLINGS

with your choice of
44 FINISHED BORE SIZES

Off-the-shelf delivery for your immediate needs! That's what Sier-Bath offers you on standard types of the well-known Sier-Bath Flexible Gear Coupling. Choose from a full selection of 44 finished bore sizes, available from any one of a hundred Sier-Bath distributors or on direct order to the factory.

Availability is only part of the story . . . for when you order Sier-Bath Flexible Gear Couplings you're ordering the smallest and lightest coupling made, yet it offers exceptional strength, higher rpm, greater horsepower capacity. One-piece sleeve design eliminates flanges and bolts, speeds up coupling and uncoupling operations through use of snap-rings. There's no danger of "freeze-up" even after years of service. Priced generally *below* competitive brands!

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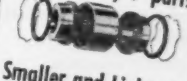
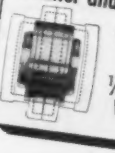
Simpler! only 7 parts



Smaller and Lighter!



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Circle 604 on page 19

If your VACUUM or PRESSURE requirements are in this range

Vacuums to 27" Hg.
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Displacement:
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. . . save space - - simplify mounting --eliminate troubles--improve operation

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LEIMAN
Integral Rotary
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MODEL K. 3.6 c.f.m. ½ hp.
13½" long - - 12" wide - - 7" high

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- Steel wings for long wear
- Automatic Wing Adjuster
- Automatic oiler—requires filling only once in 60 to 80 hours.
- Ball bearings for quiet running
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- Fan cooled—may be run 24 hours a day, 7 days a week
- Automatic thermal overload motor protection
- Noiseless operation
- Inlet filter and outlet separator
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Automatic Wing Adjuster
Patented Leiman feature adjusts automatically, pushes steel wings into contact with cylinder wall, assures constant seal, prevents wings from sticking or binding.

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Write for detailed folder and 12-page catalog showing many other Leiman pumps.

LEIMAN BROS, Inc.

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Circle 605 on page 19

MAYLINE

Mayline has the Outstanding Buy in Steel Base 4-Post Tables!

Notice in particular the following features of Mayline tables. *Base is of heavy gauge steel. *Wood feet have inset no-mar levelers. *All metal drawers run on ball bearing rollers. *Top is solid basswood with steel edges. *Available in 5 top sizes and 5 combinations.

For complete information and prices, write the Mayline Company.

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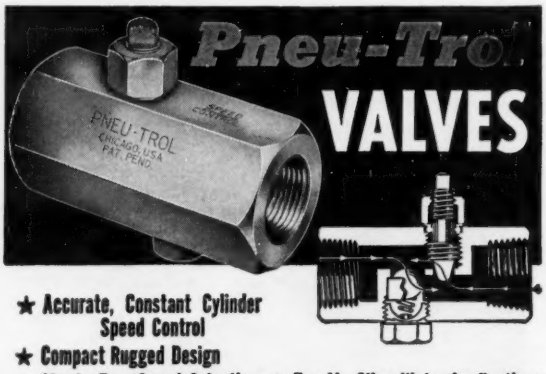
MAYLINE

Circle 606 on page 19



★ Accurate, Constant Cylinder Speed Control
★ Compact Rugged Design
★ Simple, Easy Speed Selection ★ For Air, Oil or Water Applications

Pneu-Trol Speed Control Valves, are widely used in hundreds of control applications because they combine in a short, compact body, a tapered fine thread needle for extremely accurate air or oil flow control and a floating retro ball check, which permits full flow in the opposite direction. Retro ball floats in most sensitive position to its seat, requiring only a slight differential pressure to fully open or close it.

Needle design permits maximum flow capacity in the controlled direction. Metal to metal needle and ball seats insure long trouble-free service. Simple, practical "O" gland structure eliminates troublesome leaking. Valve bodies machined from hex brass or aluminum for 2000 psi working pressures; steel and stainless steel for 5000 psi. Made in 5 female pipe sizes—⅛" to ¾". ATTRACTIVE PRICES . . . IMMEDIATE DELIVERY.

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Pneu-Trol DEVICES, INC.

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Circle 607 on page 19

NEW SILENCER
for air exhausts

High noise levels are effectively reduced by a new silencer developed by Air-Maze Corporation. Fits directly to exhaust ports or piping. Breaks up shock waves to attenuate objectionable noise without noticeably impairing efficiency of air operated equipment.

Standard sizes for ⅛"- ¼"- ⅜"- ½"- ¾" pipe sizes.

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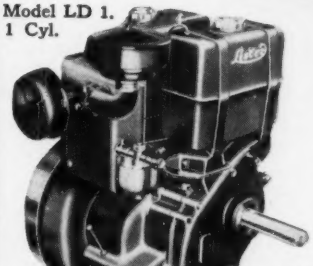
Circle 608 on page 19

What You've Long Wished For!

AIR-COOLED SMALL DIESELS *by* Lister

Model LD 1. 1 Cyl.



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ECONOMICAL
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Primary, Auxiliary and Emergency Power

Simple, durable, amazingly compact engines. Outstanding adaptability. Immediate starting, complete air-cooling, in temperatures from sub-zero to 130° F. Surprisingly low weight per diesel HP. Real fuel-misers! Quick, easy installation.

Model LD1 1 cyl. *3½ HP @ 1800 RPM Only 24½" high, 22" wide
Model LD2 2 cyl. **7 HP @ 1800 RPM Only 28" high, 25" wide
*5 HP Gross Rating **10 HP Gross Rating

Readily available Parts and Service. Write for details & attractive prices.

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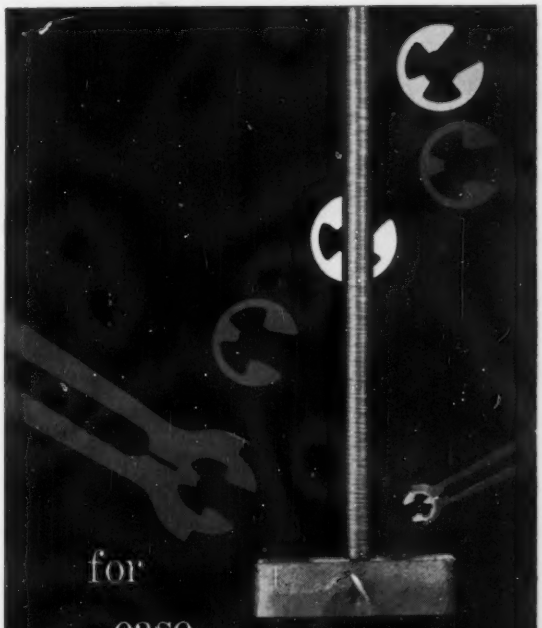

for ease, speed and economy of production . . .

INDUSTRIAL stacked RETAINING RINGS

Seven years ago, INDUSTRIAL originated Stacked open-type retaining rings to save time, labor and costs involved in selecting, untangling and applying unstacked open-type rings. Today, INDUSTRIAL Stacked Rings are used . . . re-used . . . ordered and reordered on countless assembly lines.

INDUSTRIAL Series 1000 Rings are shipped stacked on metal rods ready for use. INDUSTRIAL's patented dispenser base* holds ring stack erect and the INDUSTRIAL Applicator reduces ring dispensing and application to one motion. Waste motions and ring loss through handling are completely eliminated.

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IRR *Originators of modern retaining ring dispensing*

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For years, we've been custom-making relays to fit a wide range of applications. Manufacturers everywhere patronize our shop. They say we suit them to a "T". Our master craftsmen are ready to create a relay that will suit you, too.

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Inquiries Invited

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RELAYS • SOLENOIDS • COILS • SWITCHES • HERMETIC SEALING

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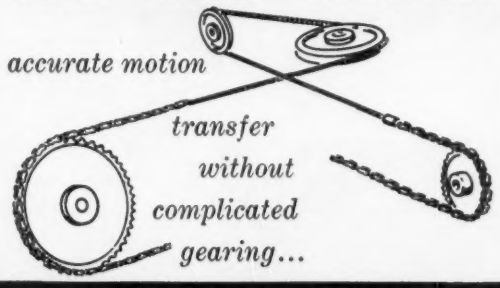
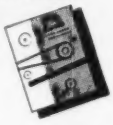
MORE DESIGN FREEDOM



SIERRA MINIATURE MECHANICAL CHAIN AND SPROCKETS...

Provide precise, positive motion transfer through several planes simultaneously with no cable slippage...no complicated gearing. Unlimited center-to-center selection for miniature and sub-miniature assemblies in servo systems, gyro systems, special cameras, electronic equipment, and small precision instruments. Less weight, cost, maintenance —wider tolerances. Designed to operate around minimum 7-tooth sprocket with root diameter of .250 inches. Chain pitch .1475 inches; Weight .45 oz. per lineal ft. Material: stainless steel, or other materials, including non-magnetic beryllium copper.

NEW CATALOG



Contains useful application data, specifications, tables on chain pitch and sprocket sizes, suggestions for calculating center-to-center distance. *Write for yours today.*

123 E. Montecito Avenue,
Sierra Madre, California

Sierra ENGINEERING CO.

T. M. REG.

Circle 612 on page 19

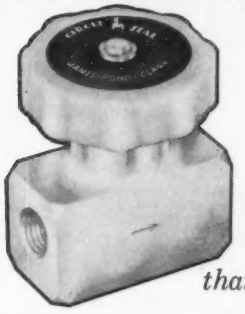
Dependable, Trouble-Free! Gentlemen,

"I know. It's the shoe that supports the crosshead in this Ingersoll-Rand compressor. It's all one piece because this Alcoa alloy is strong, needs no hard backing."

"Sure, that's how Alcoa makes bearings. Nothing to come apart. No hard backing to damage other parts in the unlikely event of bearing failure."

a manual

SHUT-OFF VALVE



that doesn't leak

- "O" Ring seal for dead tight shut-off
- Liquid or gas service to 3000 psi
- 303 stainless barstock body
- Design permits throttling

This valve can also be furnished with a toggle handle and is available in 1/4 inch female pipe size and 3/8 inch female tube size. It may be serviced ("O" Rings replaced) without removing from the line. This 900 series valve, incorporating an "O" Ring seal, is not dependent on a metal to metal seat thus eliminating gauling or scoring and assuring extremely long cycle life with ZERO LEAKAGE.

CIRCLE SEAL PRODUCTS COMPANY, INC.
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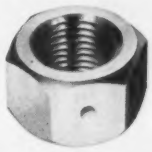


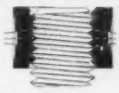
THE M·F TWO-WAY LOCK NUT

DOUBLE CHAMFERED ALL-METAL RE-USABLE

Starts from either end—locks in body of nut, not at the crown.

FOR FAST, AUTOMATED APPLICATION, WITHOUT SELECTIVE DEVICES

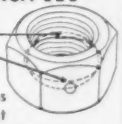
MORE LOCKING POWER WHEN BOLT ENDS MUST BE FLUSH WITH NUT



Because the locking device is in the body of the nut, not at the ends, the lock is farther from the end of the bolt—a more positive lock even when all threads are not used!

TWO LOCKING PRINCIPLES

TWO POINTS OF LOCK



Ovalized as well as deflected at point of lock. Opposing center pressure points give 180° spring.

OFF-THE-SHELF SIZES

SIZE	THREADS PER INCH		FULL THICKNESS WIDTH ACROSS	FULL THICKNESS THICKNESS
#10 *	32	24	7/16	7/32
1/4	28	20	7/16	7/32
5/16	24	18	1/2	17/64
3/8	24	16	9/16	21/64
7/16	20	14	5/8	3/8
7/16	20	14	11/16	3/8
1/2 †	20	13	3/4	7/16
9/16	18	12	7/8	31/64
5/8	18	11	15/16	35/64
3/4	16	10	1 1/8	41/64

* 1/4" Blank † Available Jam Thickness in 1/2" and Over.

MAC LEAN-FOGG
Lock Nut Company 5535 N. Wolcott Street, Chicago 40, Ill.

Circle 614 on page 19

You Can't Beat This Alcoa Alloy Bearing!

"Very unlikely! Alcoa bearing alloy embeds well, resists scuffing and overheating. Also it's highly conductive, in many machines runs 20° cooler than other bearings."

"Alcoa bearing alloy is so good it's used for this compressor's main and crankpin bearings, too. And although bearing loads on compressors are well under 1000 psi, Alcoa alloy can take up to 10,000 psi where required."

"No other bearing metal has aluminum's unmatched combination of advantages. Get more information. Write: ALUMINUM COMPANY OF AMERICA, 1986-J Alcoa Bldg., Pittsburgh 19, Pa."

Circle 615 on page 19

"MONOBALL" Self-Aligning Bearings

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	ANALYSIS	RECOMMENDED USE
1	Stainless Steel Ball and Race	For types operating under high temperature (800-1200 degrees F.).
2	Chrome Alloy Steel Ball and Race	For types operating under high radial ultimate loads (3000-893,000 lbs.).
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THE TREND IN DRAFTING ROOMS THROUGHOUT THE WORLD IS TOWARD IMPERIAL, THE WORLD'S FINEST TRACING CLOTH

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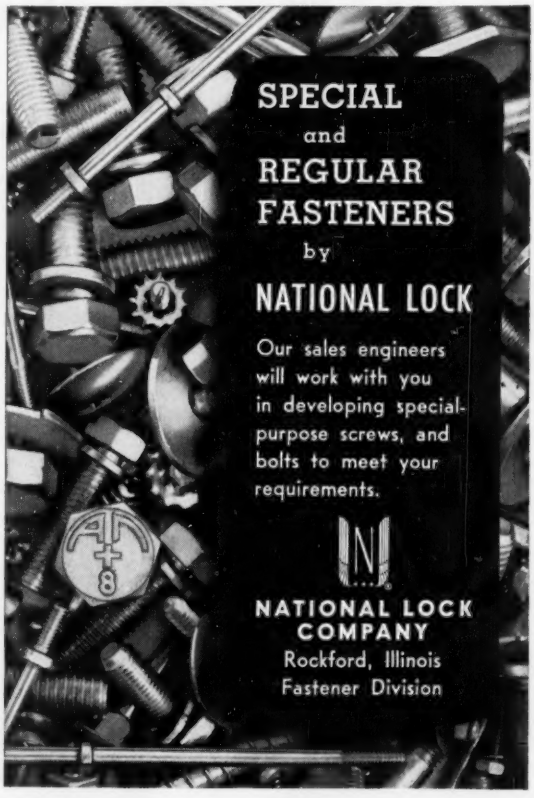


Circle 616 on page 19

Circle 618 on page 19

Why new PARKER Floats are better than cork or metal

Better than cork! Lighter, can be used in higher temperatures. Parker sealed-cell rubber floats need no protective coating, are resistant to fungus. Won't become waterlogged. Maintain stable weight and volume.

Better than metal! New Parker sealed-cell rubber floats won't fail from vibration or punctures. Can be drilled or machined.

Where can you use them? For all types of aviation and jet fuels, oil, water, and many other liquids. Can be molded in variety of shapes and sizes, with or without metal arm.

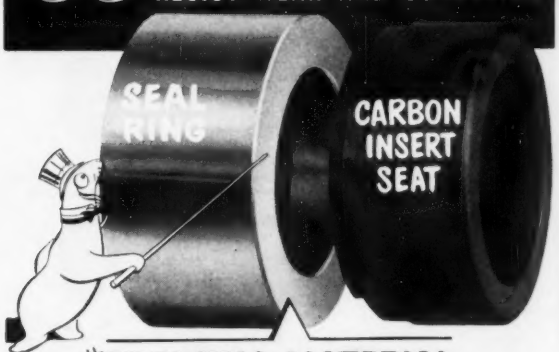
Developed by makers of widely used Parker O-rings.

Write for complete details.
RUBBER PRODUCTS DIVISION
Section 519-V
The Parker Appliance Company
17325 Euclid Ave., Cleveland 12, Ohio

Parker
Hydraulic and fluid system components

Circle 619 on page 19

#55 FACED MECHANICAL SEALS RESIST WEAR AND CORROSION



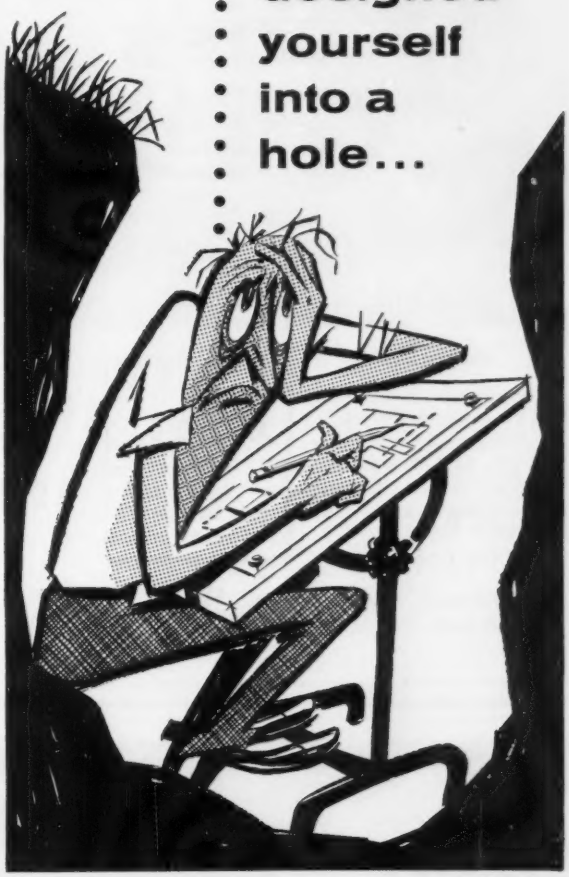
#55 FACING MATERIAL

A new and superior facing material is now available on the engineered mechanical DURA SEAL. #55 faced seal rings are long-wearing, operate at extremely high or low temperatures, and present highest resistance to wear and corrosion. #55 Facing Material combines the low-friction benefits of ceramic materials with the strength and resistance of alloyed steels. For further details write for a copy of Bulletin No. MO 469.

DURAMETALLIC CORPORATION
The PERFECT SEAL
KALAMAZOO MICHIGAN

Circle 620 on page 19

IF you've designed yourself into a hole...



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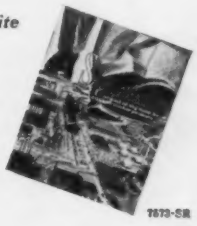
The unusual qualities of silicone rubber compounds offer opportunities for simpler, more compact designs . . . smaller, lighter units that require less costly material and labor. Stalwart-engineered silicone rubber parts can be used in a wide range of applications involving temperature extremes from —130° to +600° F. with virtually no change in their physical, chemical and dielectric properties.

Stalwart's engineers and modern production facilities are prepared to produce an unlimited variety of precision molded, extruded, automatic and hand cut parts to customer specifications. Why not write us today about your specific problem.

For further information write for Bulletin 56-SR-3



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Hardened tool steel ways, guides, and special wear plates, inseparably forge welded to tough, machineable backings. Hardness, shapes, dimensions, and mounting holes to your specifications.

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Standard and special blades of solid or composite steel, for all machine knife applications.

COES MICRO GROUND

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Design Manual

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by Leo F. Spector

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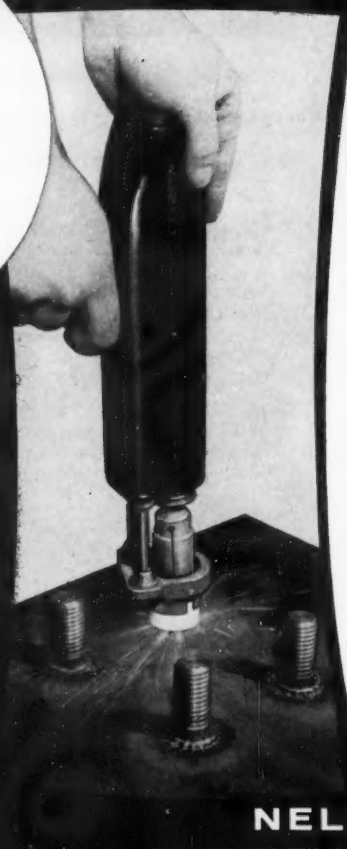

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These fastening engineers are augmented by a headquarters sales staff and 35 field sales office, warehouse and service employees, plus a nationwide organization of 18 distributors – backed up by the world's greatest pool of stud welding know-how at the Nelson Research and Development Laboratory in Lorain, Ohio.

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NELSON STUD WELDING...

AJUSTRITE®
DRAFTING CHAIR

Three Sizes
20" x 28"
24" x 32"
28" x 36"

- 2" Upholstered Seat
- No Soiled Hands Adjusting Seat
- 2-Way Adjustable Back Rest
- Full Swivel Seat

Model
RUC 2230

Just Right for
COMFORT•UTILITY•PRICE

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The 2-way posture adjustment of the back rest assures a relaxed position free of strain and tension.

Also available with round metal or wood seat, formed plywood or solid hardwood saddled seat. Gray or green finish optional.

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515 Conneaut Street Bowling Green, Ohio

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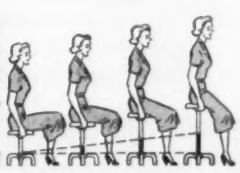
Use AJUSTRITE Chair or Stool for 30 days without obligation. Prove to yourself the many advantages AJUSTRITE offers. Guaranteed against failure due to defective material or workmanship for a period of 10 years.

SPLIT SECOND ADJUSTMENT
. . . to any *Height Desired*



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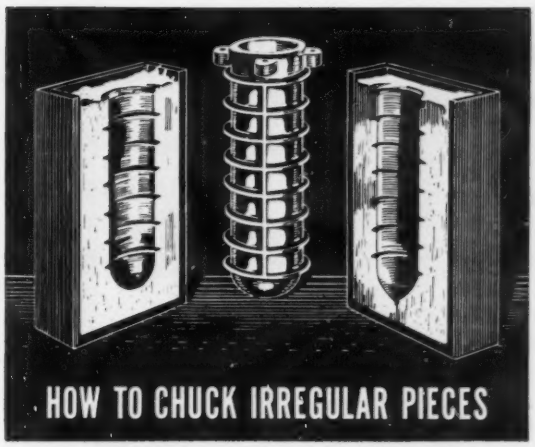

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Circle 625 on page 19

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your NELSON FASTENING ENGINEER

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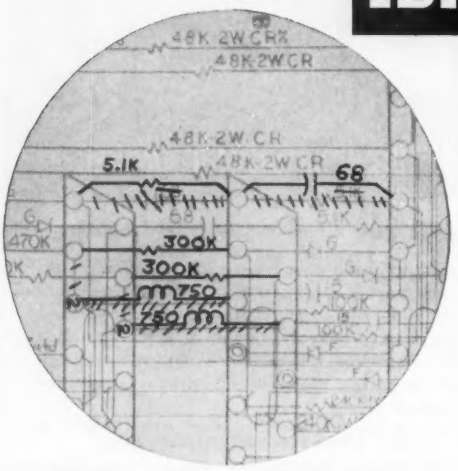

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It is significant that International Business Machines Corp., whose efforts for years have been identified with simplifying the complexities of data processing, is today combining xerography—the fast, dry, electrostatic copying method—with offset duplicating as the most efficient and economical way to deliver vital engineering drawings and change notices in time to meet production and field demands.

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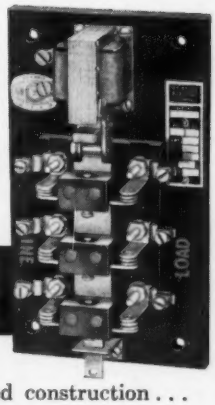

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- Simplified wiring.
- All parts easily accessible for service without disturbing other parts.
- Fine silver contacts . . . plus heavy compression springs . . . assure maximum conductivity.

Available in 1 to 5 pole, 25 and 50 amp. sizes. Other contactors, magnetically or mechanically held, up to 400 amps.

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Large-capacity, extremely accurate

DeVILBISS AIR REGULATOR

Leakproof

Fingertip adjustment

Compact size 3" x 4½"

Capacity 80 c.f.m.

DeVilbiss HAA Air Pressure Regulator. Two-stage control provides easy knob setting, sensitive regulation, less pressure drop. Offers extreme accuracy wherever controlled air pressure is needed. Regulates pressures up to 135 lbs., with only ½-lb. variation for each 10-lb. fluctuation in main line pressure! No large, heavy springs! Two inlets and three outlets (⅜" female N.P.T.) allow for any type installation. Write for details.

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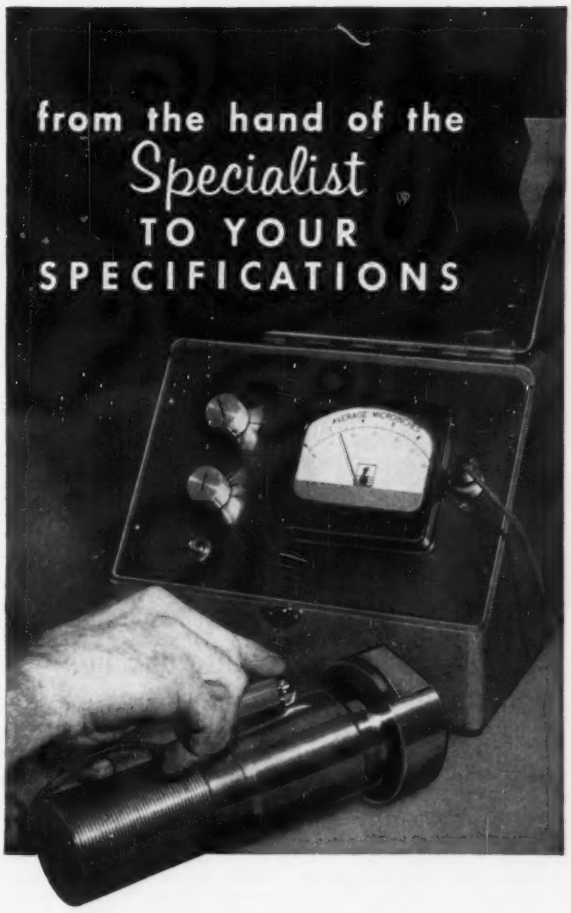

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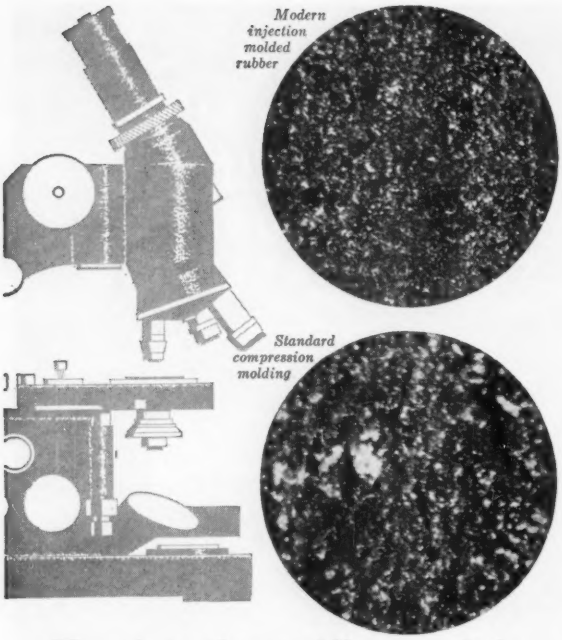

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General Motors Corporation

Flint 2, Michigan • *Milwaukee 2, Wisconsin

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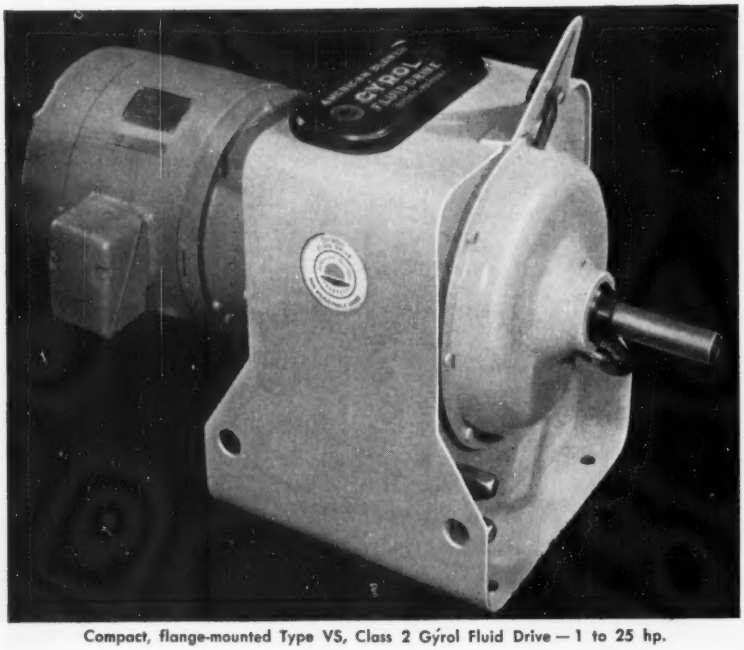

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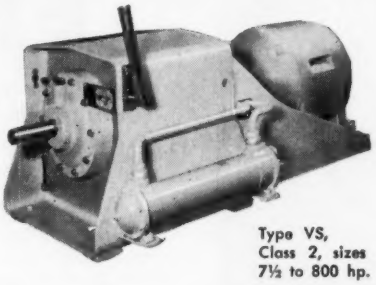
The Gýrol Fluid Drive line includes a complete range of sizes, from 1 to 12,000 hp. All save power through lower horsepower requirements. A minimum number of wear points cuts maintenance. And, because Gýrol Fluid Drives bring about reduced speeds and pressures, driven equipment lasts longer.



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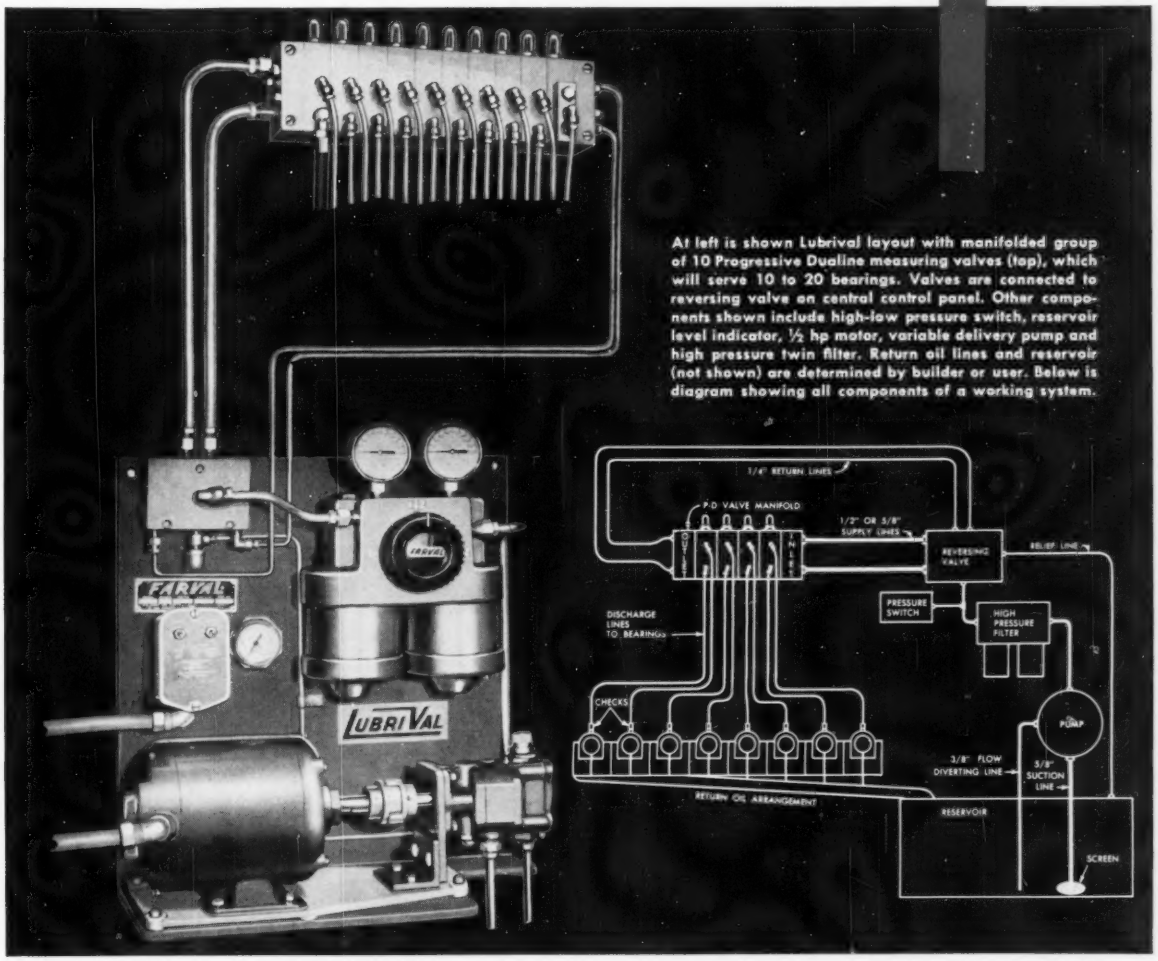

At left is shown Lubrival layout with manifolded group of 10 Progressive Dualine measuring valves (top), which will serve 10 to 20 bearings. Valves are connected to reversing valve on central control panel. Other components shown include high-low pressure switch, reservoir level indicator, ½ hp motor, variable delivery pump and high pressure twin filter. Return oil lines and reservoir (not shown) are determined by builder or user. Below is diagram showing all components of a working system.

● Lubrival is designed for low volume, high pressure circulating lubrication of presses, automatic and semi-automatic machine tools and other industrial equipment designed for circulating oil systems.

Lubrival is a Farval system, employing the Dualine principle of delivering oil to measuring valves which pass it under pressure to bearings. Lubricant is force-fed by positive piston displacement. Flow can be regulated over a range of 10 ounces to 1 gallon per minute.

Lubrival Progressive Dualine Valves, manifolded in any number required, have individual sight indicators. A pressure sensing mechanism warns of clogged or broken lines in *any part* of the system—a feature entirely new to circulating oil systems.

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KEYS TO ADEQUATE LUBRICATION—
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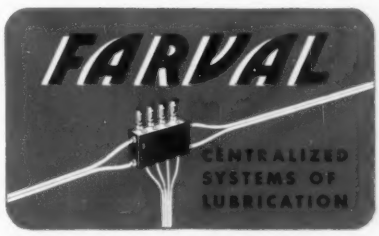

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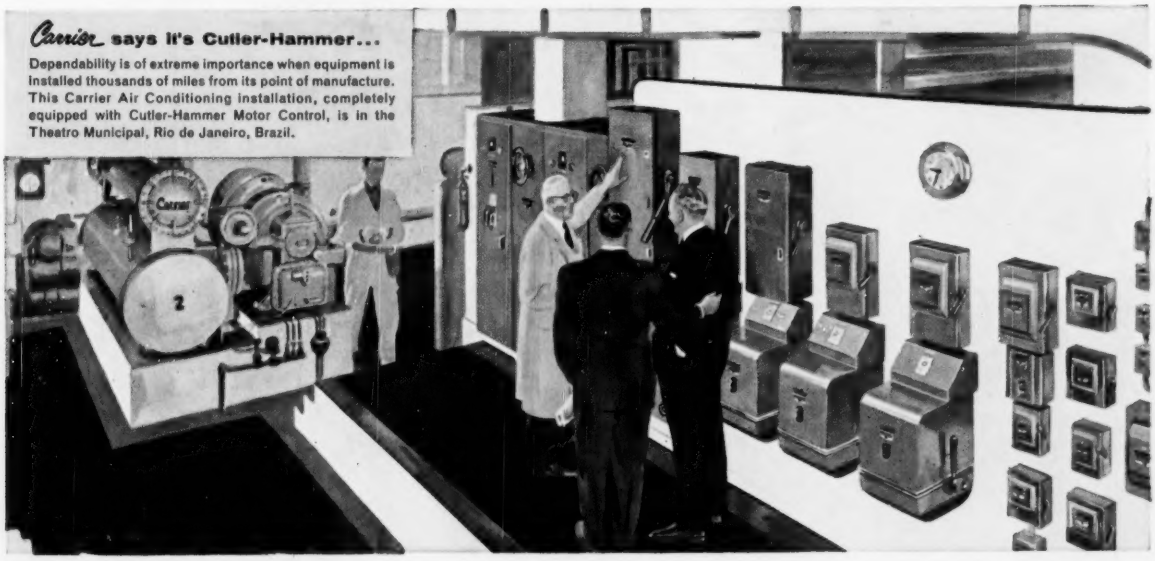
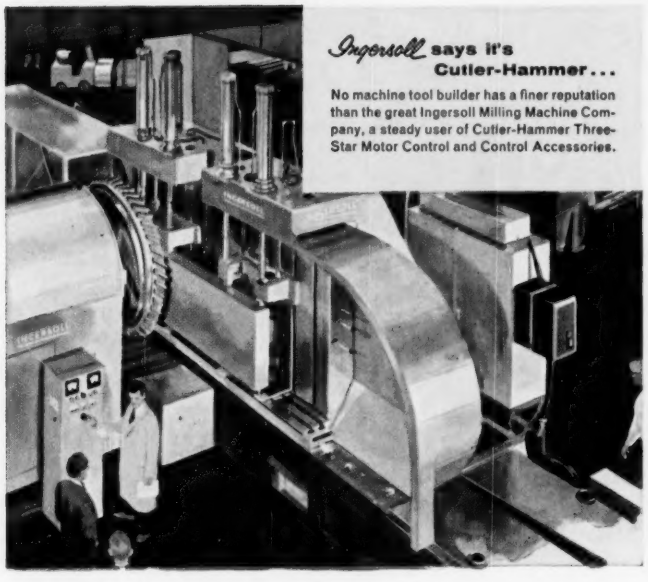
The leaders have a name for it



Carrier says it's Cutler-Hammer...

Dependability is of extreme importance when equipment is installed thousands of miles from its point of manufacture. This Carrier Air Conditioning installation, completely equipped with Cutler-Hammer Motor Control, is in the Theatro Municipal, Rio de Janeiro, Brazil.



Ingersoll says it's Cutler-Hammer...

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Black and Decker says it's Cutler-Hammer...

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